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(English Edition)

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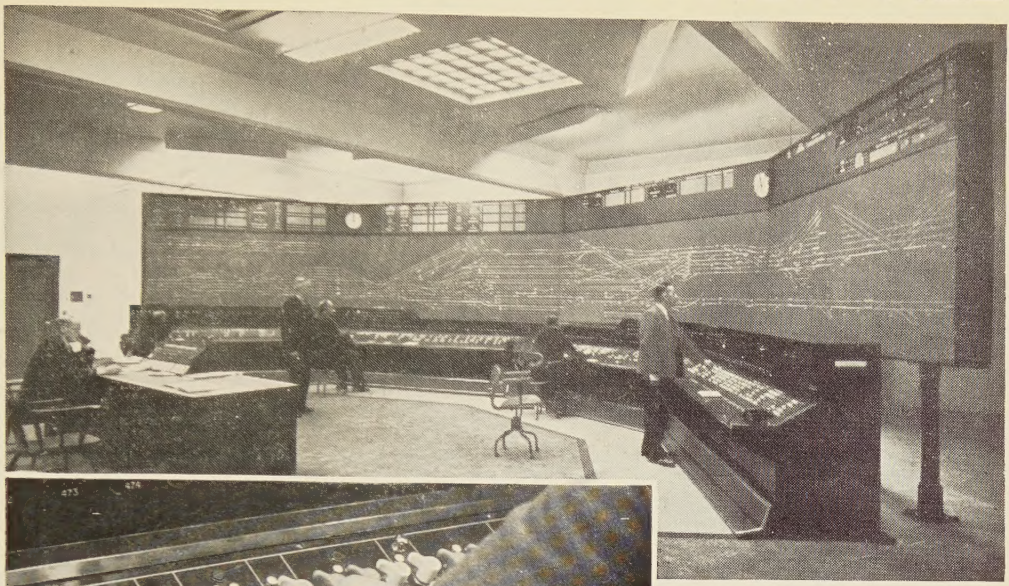

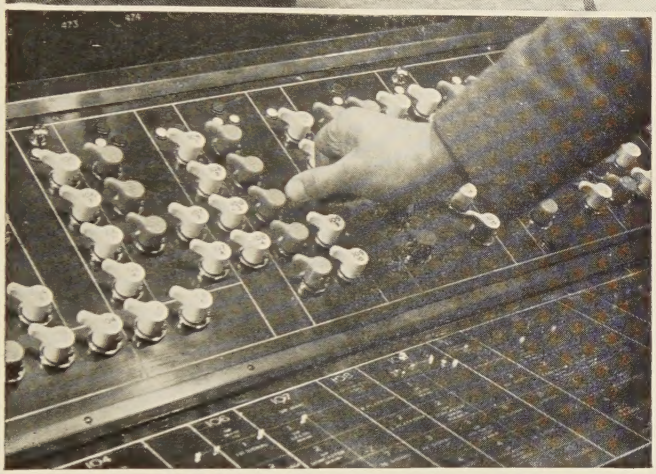

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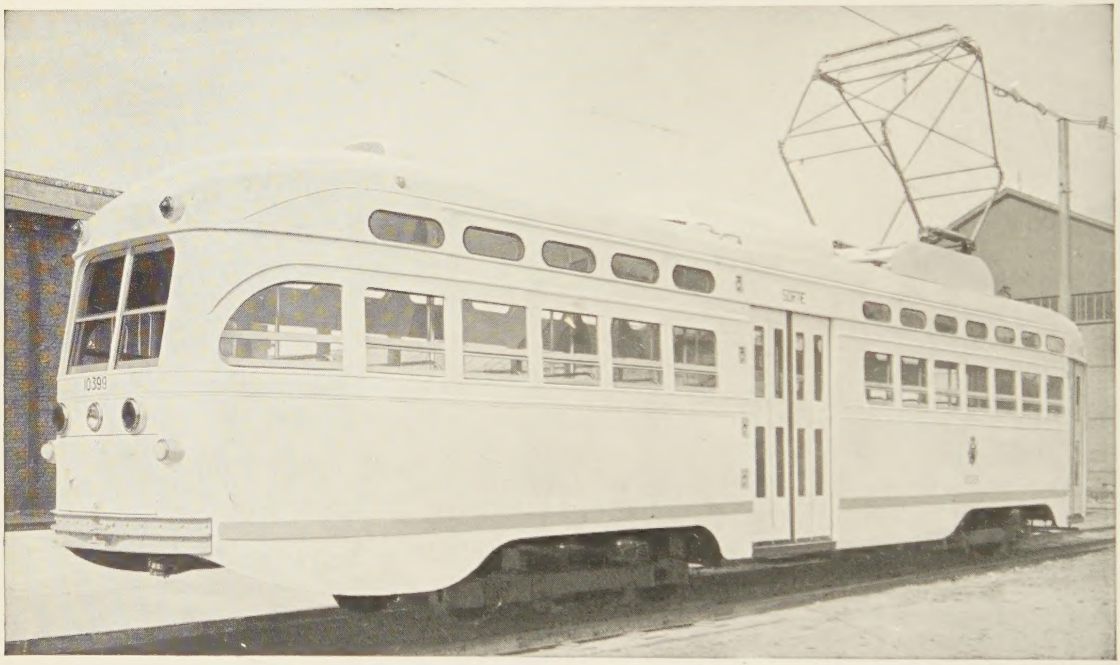

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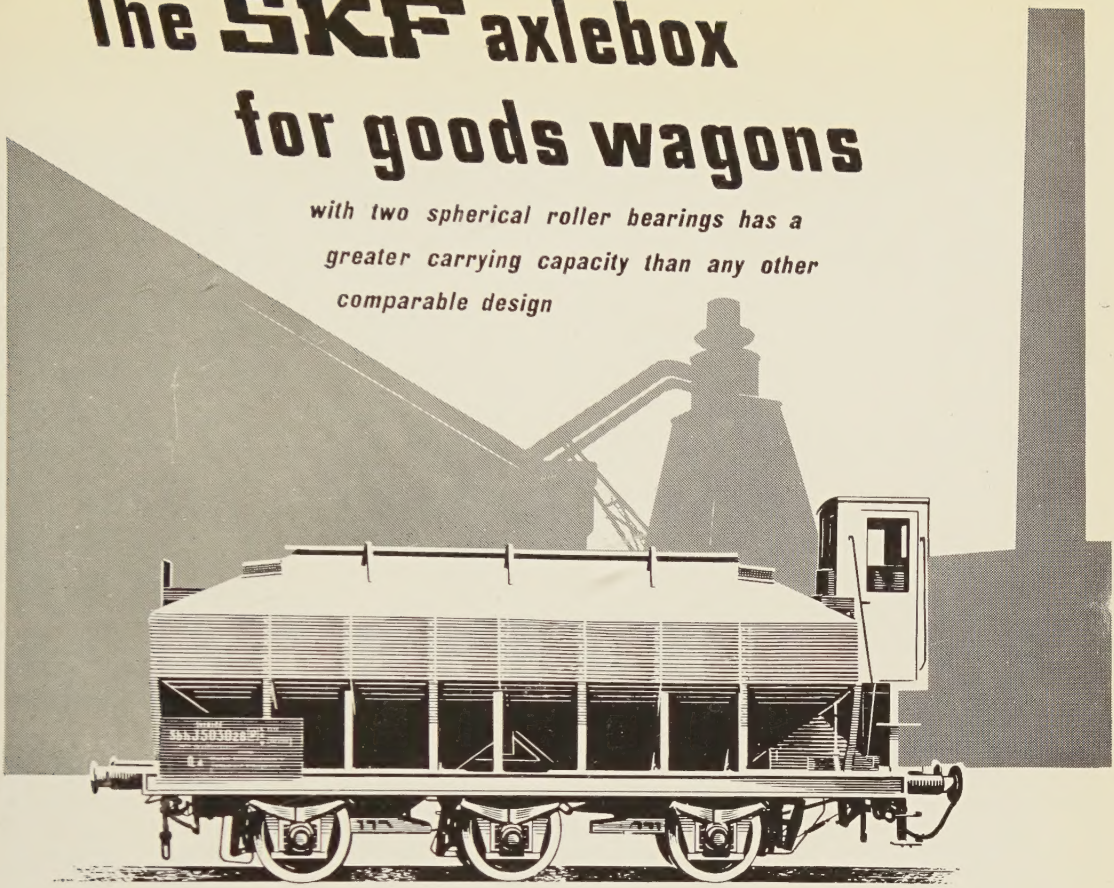

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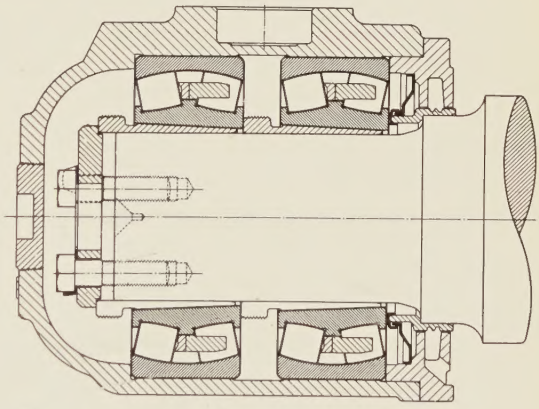

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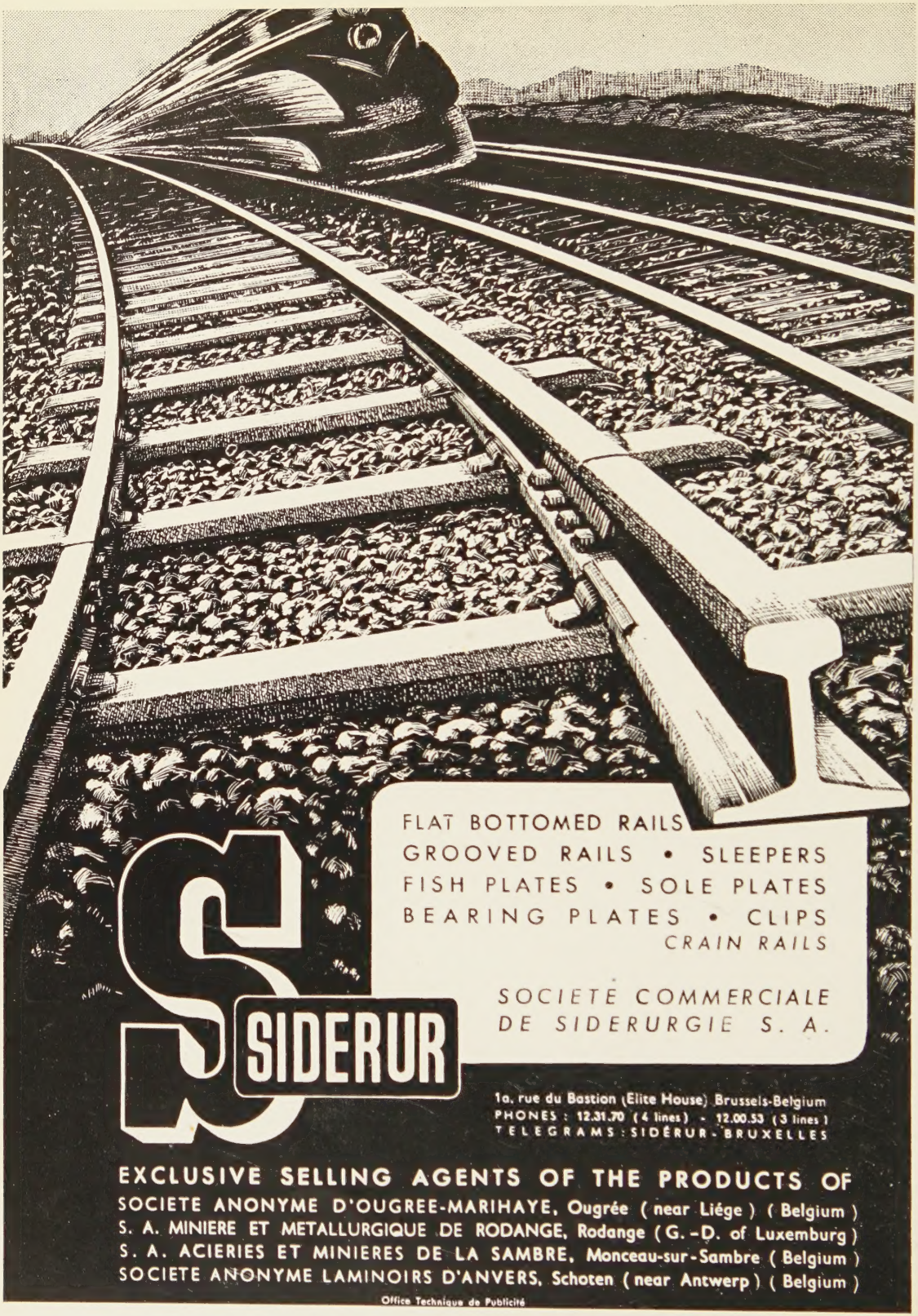
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MOULART (G.). — **Economic aspects of : a) discontinuing service on old railway lines; b) construction of new railway lines, with regard to the possibility of handling transport with other means.** (Question III, Enlarged Meeting of the Permanent Commission, Stockholm, 1952). Report *(Austria, Belgium and Colony, Bulgaria, Czechoslovakia, France and Overseas Territories, Greece, Hungary, Italy, Luxemburg, Netherlands, Poland, Portugal and Colonies, Rumania, Switzerland, Turkey and Yugoslavia)*. (12 000 words, graph & tables.)

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MATTHEWS (G.) & WILLIAMS (S.). — **A) What are the new safety measures taken for level crossing of railway tracks by the road in respect of the density, high tonnage and speed of the road traffic? B) Cases of level crossing of railway tracks by a road with a railway (urban or suburban) running alongside.** (Question I, Enlarged Meeting of the Permanent Commission, Stockholm, 1952). Report *(America [North and South], Australia [Commonwealth of], Burma, China, Ceylon, Egypt, India, Irak, Iran, Irish Free State, New Zealand, Pakistan, South Africa, Sudan, United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible)*. (11 000 words & fig.)

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SJÖBERG (Arne). — **Economic aspects of : a) discontinuing service on old railway lines; b) construction of new railway lines, with regard to the possibility of handling transport with other means.** (Question III, Enlarged Meeting of the Permanent Commission, Stockholm, 1952). Report *(America [North and South], Australia [Commonwealth of], Burma, China, Ceylon, Denmark, Egypt, Finland, India, Irak, Iran, Irish Free State, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible). (To be continued.)* (17 000 words.)

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BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[385]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(STOCKHOLM, 1952.)

QUESTION III.

Economic aspects of :

a) discontinuing service on old railway lines;

b) construction of new railway lines;

with regard to the possibility of handling transport with other means.

REPORT

(Austria, Belgium and Colony, Bulgaria, Czechoslovakia, France and Overseas Territories, Greece, Hungary, Italy, Luxemburg, Netherlands, Poland, Portugal and Colonies, Rumania, Switzerland, Turkey and Yugoslavia),

by G. MOULART,

Ingénieur en chef, Chef du service technique de l'Exploitation à la Société Nationale des Chemins de fer belges.

Introduction.

1) *General principles on which the studies were made.*

For several years all the railways have given much thought to the complicated and difficult problem of lines with little traffic, which are often called — inaccurately to our way of thinking — lines showing a deficit.

They have endeavoured by all possible means to reduce the cost of running such lines, costs which are usually out of all proportion to the receipts, in particular by reducing the installations of the permanent way, suppressing the signals, reducing the speed, frequency and composition of the trains, by making use of the most economical method of traction, by reducing the clerical and operating staff to the strict minimum.

This was what led to the idea of lines

showing a deficit, when the receipts and costs were closely gone into.

The discussion of Question XII at the Rome Congress in 1950 (*), a question which has many points in common with the present subject, proved in fact that as separate accounts were not kept for each line, no railway was in a position to draw up an accurate balance sheet for any given line.

On this occasion, one delegate observed with reason that the qualification of being a line showing a deficit was merely relative and deserved to be given greater precision. He even added that in certain circumstances all the lines of a railway system might show a deficit.

It is a fact that once all the operating costs have been reduced to the greatest possible extent, whether the balance sheet will show a profit or a debit depends upon the receipts and consequently upon the rates. Any modification of the latter will therefore affect the financial results.

In our opinion, therefore, it is to no purpose to establish merely by comparing the expenditure and receipts any criteria to determine which lines might be closed down.

And even, if such accounts were possible, what costs should be taken into account? As far as the traction costs are concerned, are we to include expenditure on the locomotive sheds, on maintenance and the sinking fund charges for the rolling stock (locomotives, coaches and wagons), the general costs and the social charges? Nothing is less certain.

The fact that certain lines are closed down does not mean that the indirect expenditure mentioned above will be reduced in the same proportion that it affects the cost of running such lines.

Important studies made on the Belgian Railways covering 2 000 km (1 240 miles) of lines out of a total of 5 000 km (3 100 miles), studies which even went as far as getting out the new locomotive and train services, showed that doing away with the train services only saved about 75 % of the total traction costs (direct and indirect costs).

The item « receipts » is equally uncertain. Does it mean the receipts from the passenger-kilometres and tonnes-kilometres running over the line, or must a part of the receipts from other lines of the system be included? This depends first of all on the steps taken to assure the traffic of the closed down line by other methods of transport (buses, lorries) or whether the traffic is simply abandoned.

And in the latter case, if a partial or total loss of these receipts is taken into account, will there not be certain traction economies on the adjacent lines?

Looked at from this point of view, it does not seem to us that the problem can be solved in any formal and certain way.

We think it preferable, in order to determine the value of substituting road services for railways services on lines with little traffic, to calculate, after getting out the new timetables for the rolling stock and staff on the adjacent lines covered by the same services, the reduction in the traction and operating costs, including those relating to the cost of maintaining the track, the buildings and the signalling, the station staff and crossing keepers.

A comparison of the total saving and the cost of the road services (the buses on the one hand and the lorries on the other), as well as the possible loss of receipts, will make a sound decision possible. It will even be possible to determine, without difficulty, the financial advantages to be derived by substituting road services either for the passenger traffic only, or for both passenger and goods.

If the railway is able to assure such road services, there will not as a rule be any loss of receipts to be taken into account.

A loss will only occur in fact if the traffic is simply abandoned, which most railways, in view of the fact that they are

(*) See the *Congress Bulletin* for the month of October 1951, p. 697.

public services, will not be allowed to do by their Government.

2) *Advantages and obligations of road services.*

Having thus defined in a rational fashion the case in which it is to the interest of the railway and of the community to change over from railway to road services, the railways will achieve a double objective : they will be acting in a realistic and co-operative fashion, and they will force the State — with which the ultimate decision generally lies — to face up to its responsibilities.

They will be acting in a realistic fashion because the progress of road transport is undeniable, and it would be futile to refuse to recognise the advantages it presents in certain cases; because the road services are very far from being what they were when the railways were created and at their peak, because the era of railway monopoly is definitely a thing of the past.

They will be acting in a cooperative fashion because the comprehensive attitude of the railway will give a lead to any Government that is still undecided about the policy to be followed in the rational choice of the most appropriate and most economical method of transport.

The State will be forced to face up to its responsibilities because, being disinclined to act fairly as regards the maintenance of the permanent way and the roads, the latter alone being maintained at the expense of the community, it will be forced not only to make suitable roads as regards layout, width and surface, but also to keep them open for all types of transport at all times. They will be forced, for example, like the railways, to take the necessary steps to keep the roads open when the weather is snowy, icy or foggy. It is not to be expected, and would be anti-economic, that the railway having given place to the road in certain cases, should be retained simply as a standby.

The use of disused railways as roads would result in great advantages from this point of view on account of their advantageous characteristics.

It should also be pointed out that in determining the most economic method of transport, it is necessary to take into account the kind of goods to be transported and the types of vehicles needed for this purpose, as well as the number of vehicles needed to meet any possible traffic peaks.

Finally we must point out that planned in this way, the substitude road services organised by the railways will not mean any additional transhipments of goods.

They will even make it possible to organize door to door services for full loads, an advantage appreciated by the public.

3) *Reactions of the public and political interventions.*

Railways which have undertaken the partial or total substitution of road services for railway services have frequently come up against a certain opposition on the part of the public and the representatives of political interests.

Animated in most cases by a conservative and routine-loving spirit and wishing to have at their disposal both methods of transport which each have their advantages in given circumstances, and give the district an appearance of importance which it may not merit, the public and the politicians do everything possible to keep the railway open.

The application of railway tariffs to road transport, the desire to assure just as satisfactory services as those by rail, and a persuasive and well-informed attitude combined with firmness should in the end overcome such resistance.

In many cases, on the Belgian railways, after severe opposition at first, the public has ended by recognising that the bus services give them greater facilities than the train services, due to the fact that they run right through the towns, give a more frequent service and more frequent stops.

This aspect of the problem should not therefore be retained as an obstacle to closing down railway lines.

4) *Evolution of the conditions of transport.*

Another argument frequently put forward to oppose the closing down of a line is the fact that the economic conditions which justified the construction of the line still apply.

This reasoning overlooks two essential factors of the problem : in former times there were merely rudimentary roads and animal traction. Under these conditions, it was essential to get the traffic, to build the stations near the producing centres, even if these were not very important.

Good roads and motor traction have completely altered the position. Once the goods are loaded onto a lorry, it does not matter if they have to travel a few miles more or less.

It is certain that many secondary lines would never have been built if the present road transport facilities had been available at the time.

5) *Questionnaire.*

As regards part *a*) of the question (*discontinuing service on old railway lines*), the questionnaire was drawn up according to the point of view we have just explained.

As few railways have actually done anything, detailed figures are rare.

In spite of this and in spite of certain disagreements, we will endeavour to determine the approximate limits of traffic to be taken as a guide in selecting which lines should be closed down.

We will also endeavour to ascertain what savings can be taken into account, so that some estimate of the probable results can be arrived at.

With this object, we found it necessary to divide the problem up and consider separately the case of the passenger and the goods traffic.

We hasten to add that the figures given in the conclusions we arrived at are simply indications, and can be affected by the special operating conditions of each railway and even of each different regions of the same railway, as well as by costs.

We make our excuses, but everyone knows that all a reporter can do is to use as best he can the information given him.

We wish to thank in particular those Railways, who were good enough to give us detailed information in this difficult and little known field.

The political and social aspects of the problem of closing down railway lines has not been gone into as the question set was limited to the economic aspects alone.

As regards part *b*) (*the construction of new lines*), the problem has many variants. In order to arrive at certain conclusions in spite of this, we had to make certain hypothesis regarding the length of lines, the nature of the traffic, the cost of building a railway and a road, the cost of the two methods of transport in question. We also had to suppose that the line or road in question would be operated independently of any other.

This last hypothesis is very close to reality because, according to the discussions on Question XII at Rome and the replies received to our questionnaire, it appears essential that the construction of new lines will only be considered in the case of new countries where the railway is as yet hardly developed.

* * *

a) Closing down old railway lines.

QUESTION 1. — *If you had a completely free hand in the matter which are the lines you would decide to close down either entirely or partially (passenger traffic, parcels traffic, full loads) ?*

Give a list of these lines together with their characteristics : gauge, length, volume of traffic (train-kilometres, passenger-kilometres, tonnes-kilometres) and all other interesting details.

Have you established any criteria to determine which lines come into this category? If so, please explain them.

a) All the European Railways report that a larger or smaller proportion of their lines could be closed down to passenger traffic and replaced by bus services.

In the case of goods traffic, opinion is more divided owing to the fact that the methods available for sending goods by road are not yet sufficiently perfected.

Certainly a wide range of vehicles are available : various types of containers which can take up to 5 tons useful load, U. F. R. trailers, wagons-conveying trailers. But with the exception of the latter, they cannot be used to carry all categories of goods, and are relatively costly as soon as the distances exceed 15 to 20 km (9 to 12 miles). In addition they involve the use of special stock the cost of which is prohibitive if the user is not sufficiently good.

Use is only made of wagon-conveying trailers when the goods are such that they have to be loaded onto a wagon. The running of such trailers is generally by special licence owing to their size and weight (40 to 60 t when loaded), which is often incompatible with the load authorised for bridges.

Their speed does not exceed 20 to 25 km (12 to 16 miles)/h so that their use for distances of more than 15 km (9 miles) cannot generally be recommended from the economic point of view.

In the text which follows the following abbreviations have been used :

French National Railways : S. N. C. F.
Belgian National Railways : S. N. C. B.
National Light Railways (Belgium) : S. N. C. V.
Deutsche Bundesbahn : D. B.
Swiss Federal Railways : C. F. F.
Luxemburg Railways : C. F. L.
Netherlands Railways : N. S.
Italian Railways : F. S.

However, the adaptation of the permanent way into a road with eminently favourable characteristics, would modify these conclusions since the speed could be increased and consequently the economic limits of transport.

We will not deal with the parcels traffic, the volume of which is small on lines of the sort in question, and the terminal transport of which by road would present no difficulties.

b) Although no railway has established any real criteria to determine which lines could be closed down either completely or in part, the investigations and realisations of the Deutsche Bundesbahn, the Luxemburg Railways and the Belgian National Railways supply some valuable information.

The traffic characteristics of these lines are summed up in the table on the following page.

Some of these figures, which do not seem to agree in any way, require further explanation.

As regards the passenger traffic, these figures correspond to a daily traffic of about :

— 380 passengers in the case of the D. B.
— 210 passengers for the C. F. L.
— 620 passengers for the S. N. C. B.

Such traffic can be worked by bus without difficulty. It represents a number of traffic-km units per year and per km of lines varying from 80 000 to 225 000.

As regards the goods traffic, it corresponds to :

2 wagons (32 t useful load) per day for the D. B.
— 1.5 wagons (22 t useful load) per day for the C. F. L.
— 26 wagons (420 t useful load) per day for the S. N. C. B.

The latter amount is due to the fact that on some of the lines investigated transit traffic runs, the diversion of which would

Railway	Numb. of lines	Total extent in km	Train-kilometres (per year)			Traffic-units (per year)			Train-km per km of line	Traffic units per km of line
			Passenger	Goods	Total	Passenger-km	Tonne-km	Total		
D.B.	9	124	623 000	98 000	721 000	17 120 000	1 187 000	18 307 000	5 814	147 637
C.F.L.	4	112.8	—	—	507 000	8 663 000	748 000	9 411 000	4 494	83 430
S.N.C.B.	24	380	1 790 000	245 000	2 035 000	85 000 000	49 000 000	134 000 000	5 355	352 631

have to be examined if the full load services were closed down.

We will show further on that the daily traffic should not exceed 13 wagons on lines of 10 km, 6 wagons on lines of 20 km and 5 wagons on lines of 30 km (18 miles).

Allowing a maximum of 6 wagons, the number of traffic units a year per kilometre of line is 28 800.

As on the other hand the number of train-km per km of line agree, we can take the limiting criteria for lines which might be closed down as being :

— train-kilometre per year per kilometre of line : 5 to 6 000;

— traffic units per year per kilometre of line : 250 000.

QUESTION 2. — *Have the economic and social circumstances which justified the construction of these lines changed appreciably since that time, especially as a result of*

a) *the shifting of commercial and industrial centres;*

b) *the competition of other methods of transport (road, waterways);*

c) *any other circumstances.*

Indeed the poor use of the railway in general and of certain lines in particular can be attributed to some small extent to the resiting of the commercial and industrial centres, or to the fact that these centres did not develop to the extent expected when the corresponding lines were built.

But the chief cause of this poor user must be blamed upon road competition, encouraged by the non-intervention policy of most Governments. There is no point in going again into the question of the freedom enjoyed by road hauliers to choose their services and the kind of goods they will carry and the rates they will charge. If we add to this the complete absence of any *obligation* to transport, even in the case of the services and categories of goods they are carrying, and the small share in

the capital charges, sinking fund charges and maintenance cost of the road with which the road hauliers are taxed, the diagnosis of the illness from which the railway is suffering is complete, which is forcing them to consider reducing or closing down their activities in districts with little traffic.

The restrictions on the rates which have been imposed since the war by all Governments for political and psychological reasons rather than economic ones has further increased and developed this trouble.

Up to the present, colonial railways have escaped road competition and are still benefiting by a transport monopoly. This however is beginning to be endangered by the construction of roads which is taking place in Africa.

QUESTION 3. — *Where this applies, the reasons why these lines have not been closed down : government opposition, difficulty of providing substitute services, etc.?*

Owing to the inadequacy of methods of transporting full loads by road, proposals to close down railway lines completely are rare :

— *D. B.*	60	km (37 miles)
— *C. F. L.*	112.8	km (70 miles)
— *C. F. F.*	55	km (34 miles)
— *S. C. N. F.*	144	km (89 miles)

These proposals are subject to the approval of the respective Governments, which has only been obtained in the case of the Swiss lines, for safety reasons as the lines in question had a great many dangerous level crossings where there were frequent accidents.

The systematic opposition of the Government to the closing down of lines is due to the intervention of political interests and those of the regional economic groups, who would rather see the general economy of the country burdened by useless charges than admit the rational consequences of the small contribution their district makes to railway traffic.

On the other hand, the closing down of passenger services and replacing them by bus services has been wide-spread :

— *S. N. C. F.* . . . 12 300 km (7 643 miles) or 30 % of the system;

— *S. N. C. B.*, completed 380 km (230 miles) proposed 200 km (124 miles) or 11.6 % of the system;

— *S. N. C. V.* . . . 1 500 km (932 miles) or 33 % of the system.

This change is of great value as it makes it possible, as we will show later on, to make savings of as much as 75 % of the whole of the saving due to closing down a line.

QUESTION 4. — *In the case of such lines, have you made any comparison between the loss of receipts and the savings in operating costs to be obtained by the suppression of the passenger services or all the services, both passenger and goods.*

If you have made any studies in order to prepare balance sheets for the partial or total closing down of secondary lines, please give a few examples.

Only four railways (the German, Luxemburg, Netherlands and Belgian Railways) quoted figures of any real interest. These are summed up on the next page.

Let us hasten to point out that for the reasons explained in the introduction, there will be no loss of receipts if the Railway itself assures the replacement road services. But in this case the operating costs are likely to be higher.

It can however be stated that the saving to be expected will be of the order of :

— 150 000 Belgian francs per kilometre, when the line is completely closed down, not taking into account the cost of replacement road goods services;

110 000 Belgian francs per kilometre, or 75 % of the total saving, when only the passenger services are closed down and replaced by a bus service.

Railway	Number of lines	Extent in km	Services closed down	Total saving in Belgian francs	Saving per km of line in Belgian francs
D.B.	2	25	passenger and goods	no loss receipts : 3 600 000 at a loss receipts : 2 052 000	144 000 82 080
C.F.L.	4	112.8	ditto	no loss receipts : 27 405 000 at a loss receipts : 22 150 000	242 952 196 365
N.S.	1	37	passenger only	5 724 000	154 702
S.N.C.B.	24	380	passenger only	41 685 000	109 700
	3	35	passenger and goods	6 305 000	180 140

QUESTION 5. — *Do you make use of different operating methods and rates on these lines than on the important lines? If so, please give details.*

The operating methods used on lines with little traffic are all intended to reduce operating costs to the greatest possible extent.

When possible the signalling is done away with and the trains run either under the control and authorisation of the man in charge of the line, or as a shuttle service, or without being announced at stated times.

In the first case, the man in charge of the line (a sort of dispatcher) regulates the running on one or several lines by means of a selector telephone post in communication with other telephone posts on the station platforms marking the limits of the block sections. All the trains have to stop at these stations, and the guard asks the man in charge for permission to enter the section. In the stations at which the trains pass each other, the change-over points normally set for the reception siding are fitted with an automatic wedging device with an indicator showing the position of the points. The trains on leaving can run through these points in the other direction.

In the second case, there is never more than one train on the line, and information is exchanged between the end stations.

When these simplified methods of working are accepted, the station traffic staff can be very much reduced or completely suppressed, and it is even possible to limit the times at which the booking office is open, or even do away with it altogether, fares being collected on the trains.

Limiting the speed often makes it possible to do away with keepers at the level crossings and reduce the cost of maintaining the permanent way.

In general, the rates in force on lines with little traffic are the same as those on the other lines of the system. However the S. N. C. F. has recently introduced a system of classifying the stations in the case of the goods tariffs. There is a tendency to modify the rates according to the cost by means of coefficients applicable to the end stations of the railway journey. The result is a differentiation in the rates between the main lines with their low costs and the secondary lines with their higher costs.

QUESTION 6. — *What measures are you considering in order to improve the efficiency of the secondary lines?*

Apart from the measures mentioned under Question 5, there is unanimous agreement about the use of Diesel traction which makes it possible to improve the timetables, even without any increase in the speed, and also to increase the number of trains without any excessive cost.

When, from the point of view of the passenger traffic, the use of railcars would still be too costly in view of the small number of passengers, there is nothing to be done but go over to road services and make use of buses.

As regards the transport of goods, an interesting step taken by the Italian Railways should be mentioned: they are using motor-wagons running on petrol, with a limited power and fuel consumption.

QUESTION 7. — *What is the extent and percentage of lines used solely — or capable of being used solely — for local traffic, excluding all transit traffic? Are these only single track lines?*

What are the average characteristics of the passenger traffic and goods traffic on these lines :

— kind and number of trains;

— number of passengers, total and per train;

— annual number of train-kilometres per kilometre of line, per category;

— annual number of passenger-kilometres and goods tonnes-kilometres per kilometre of line;

— passenger and goods receipts per kilometre of line;

— same average figures for the railway as a whole.

The following table sums up the replies received from some of the Railways. The lines in question are all single track lines, and often dead-end lines.

Railways	Lines in km	Number of trains daily		Train-km per annum per km-line			Train-km per annum per km-line for the whole system			Ratio $\frac{a}{b}$	Per km-line-year			% unit of traffic-km for whole railway	Receipt per km	
		Passenger	Goods	Passenger	Goods	(a) Total	Passenger	Goods	(b) Total		Passenger	T.-km	Total traffic-km units		Passenger and % of whole railway	Goods and % of whole railway
D.B.	53	20	2								170 000	8 000	178 000		48 000 B. fr.	7 200 B. fr.
F.S.	—	—	—	—	—	—	—	—	—	—	300 000	125 000	425 000	—	—	—
C.F.L.	112.8	20	2	4 130	354	4 484	—	—	—	—	77 000	6 400	83 400	—	32 230	10 560
															17 %	0.83 %
S.N.C.B.	380	6 to 20	2 to 4	4 710	645	5 355	10 500	4 200	14 700	0.36	223 000	129 000	352 000	16.3 %	47 500 B. fr.	129 000 B. fr.
															0.8 %	9.6 %
Mozambique	412	17		—	—	—	—	—	—	—	83 761	32 737	116 498	—	—	—
S.N.C.F.	—	—	—	—	—	—	—	—	—	0.20	—	—	—	16.6 %	—	—
C.F.F.	21	10 to 24	2 to 4	—	—	—	—	—	—	—	142 140	39 280	181 420	7.3 %	9 571	6 285
															10 %	7 %

The information received, which is very incomplete, does not make it possible to determine any other criteria than those indicated under Question 1.

All that can be added is that those lines the closing of which can be contemplated have a traffic which does not exceed 15 % of the average traffic of the system.

QUESTION 8. — *Do the clientele and road system lend themselves generally to the replacement of the train services by an omnibus service on the lines in question?*

Taking into account the capacity of the omnibuses, would there not be an increase in the mileage run by them compared with the train-kilometres?

What would this amount to on the average?

The railways are unanimous in agreeing that a well organised bus service can meet all the requirements of their clients.

Additional vehicles can be run at peak hours. Owing to this the total mileage of the buses is generally 30 to 50 % higher than the mileage of the trains they replace.

The replacement of trains by buses is nonetheless advantageous owing to the difference in the unit costs (9 to 10 Belgian francs compared with 40 to 50 Belgian francs per km) and other substantial savings made possible by the suppression of the passenger services.

In all European countries, except Austria, the roads lend themselves very well to the organization of bus services.

QUESTION 9. — *Do the public like omnibus services?*

Do they not give better services in the towns?

What are the average and maximum distances from the middle of the town to the stations on the one hand, and to the omnibus routes on the other?

Would not omnibus services, in addition to connecting with the railway at the end stations, give all the advantages of a tramway linking up the intermediate rural centres?

Would this fact not make it possible to count on additional receipts?

Except in Switzerland, buses are liked by the public, at least in the case of journeys of less than 30 km (18 miles).

Switzerland is an exception chiefly because the bus fares are 2 to 3 times higher than the railway fares. In addition, the C. F. F. point out that the buses are not always able to deal satisfactorily with peak traffic.

This is an exceptional situation due to the hilly nature of the Swiss roads. As we will show further on, under normal conditions, the organizations of bus services is advantageous, even if the railway rates are applied.

A few railways report that the public would like to benefit by the combined advantages of the two methods of transport, the trains being in particular more comfortable and certain during the winter.

The improvements made to road vehicles, such as air conditioning and heating overcome this objection.

The bus has an important and undeniable advantage over the train in that it runs right into the towns. The average and maximum distances between the station and country towns is about 1 and 4 km (1/2 to 2 1/2 miles) (up to 15 km [9 miles] in Italy), whereas they are only 500 m (550 yards) or less and 1 to 1.5 km (1 090 to 1 640 yards) for the bus stops.

In many cases, bus services are a new form of regional transport capable of bringing in very valuable receipts about which most of the railways however gave very little information. In Belgium, increased receipts of the order of 20 % have been noted.

The flexibility of the bus services is shown not only in the possibility of increasing the number of stops and request stops,

but also the possibility of running over different routes in order to serve new places and economically increase the number of services.

From this point of view, however, there is a reasonable limit which must not be overstepped or the public will be displeased at the increase in the journey times.

QUESTION 10. — *What agreements or authorisations are necessary before a passenger train service can be withdrawn?*

Is the railway allowed to organize substitute omnibus services, or have these to be abandoned in favour of a concessionnaire?

In the latter case, how do you make sure that the timetables are so planned that the railway and omnibus services will connect?

In every country the suppression of passenger trains must be authorised by the Government.

Except in Spain, France and Holland, the railways are allowed to operate the substitute bus services either themselves or through a concessionnaire. In the latter case, the railway usually collects a certain percentage of the receipts and lays down the timetable to be followed, which must allow of the greatest possible number of connections with the train services.

In France and Holland, the running of the bus services is most often entrusted to an affiliated road transport undertaking or shared by the railway.

QUESTION 11. — *What rates do you apply in the case of omnibus services replacing a train service? Indicate the basis of such rates.*

Are all the cheap railway fares applied to the omnibus services, including season tickets?

Are tickets to all the places on the railway system available in the buses, or only tickets to places on the bus route, even if having to buy two tickets increases the cost of the journey?

Likewise do the railway stations issue tickets available on both trains and buses, or only train tickets?

All the railways apply the standard 3rd class railway rates on the substitute bus services.

Only the Belgian Railways (standard gauge and light railways) and Luxemburg Railways grant all the cheap rates applying on the railways, including the various classes of season ticket, even workmen's seasons.

The S. N. C. F. limits these cheap fares to lines operated by a road undertaking on their behalf and the D. B. to the omnibus services.

The normal rates (full tariff) are about 0.70 to 0.80 Belgian franc per km.

In general tickets are only issued in the buses for that particular service; on the other hand the stations issue combined tickets available on the railway and the extension bus services.

To avoid grumbles about the increased journey cost for passengers travelling by a substitute bus service the S. N. C. B. has taken a special precaution : at the connecting station the passenger can buy a ticket from one end of the journey to the other, and the bus fare is deducted from the price of the ticket as from the fictitious station corresponding to the point at which he boarded the bus.

QUESTION 12. — *When the railway rates are applied to the bus services, is the cost of the ticket based on the distance by road or by rail? In the former case, how are the stations compared and the bus stops compared?*

What types of tickets do you use?

On the Belgian, French, Luxemburg and Swiss railways, the price of the ticket is determined according to the distance by rail, certain bus stops being taken as equi-

Categories of staff	S.N.C.B.	S.N.C.F.	D.B.	F.S.	C.F.L.	N.S.	C.F.F.
a) *Secondary lines.*							
Station staff	0.500	0.50	0.50	1.35	0.12	0.88	0.90
Signalmen	0.015			0.10		0.16	0.21
Keepers	0.365	0.30	0.01	0.30			
Maintenance of track and signals.	0.382	0.50	0.45	0.48	0.25	1.01	0.65
Total	1.262	1.30	0.96	2.23	0.37	2.05	1.76
b) *Railway.*							
Station staff	4.00	3.30	—	3.10	—	3.25	5.10
Signalmen	1.40			0.50		0.27	0.67
Keepers	0.23	0.60	—	0.30	—		
Maintenance of track and signals.	0.70	1.60	—	1.23	—	1.55	1.35
Total	6.33	5.50	—	5.13	—	5.07	7.12
c) *Secondary lines, after suppression of passenger services.*							
Station staff	0.200	—	0.43	0.94	0.10	0.38	—
Signalmen	0.015	—		0.07		0.05	0.05
Keepers	—	—	0.01	0.21	—		
Maintenance of track and signals.	0.257	—	0.31	0.34	0.25	0.27	0.50
Total	0.472	—	0.75	1.56	0.35	0.70	0.55
d) *Secondary lines — savings due to the suppression of the passenger services.*							
Station staff	0.30	—	0.07	0.41	0.02	0.50	0.90
Signalmen	—	—		0.03		0.11	0.16
Keepers	0.365	—	—	0.09	—		
Maintenance of track and signals.	0.125	—	0.14	0.14		0.74	0.15
Total	0.790	—	0.21	0.67	0.02	1.35	1.21
%	62.6	—	21.9	30	5.4	65.8	68.7

valent to the stations (fare stages). In the case of passengers using intermediate stops, the procedure varies from railway to railway : the S. N. C. F. bases it on stops on the actual route, whereas the S. N. C. B. bases it on the distance between stations corresponding to the fare stages next to each of the stops at which the buses can be boarded or left, increased by a given distance in each case.

The D. B. bases its rates uniformly according to the distance by road, whereas the other railways (F. S. and S. N. C. V.) base it sometimes on the distance by rail and sometimes on the distance by road.

No details were given about the type of ticket used.

QUESTION 13. — *On the lines in question, what are the average numbers per kilometre of line :*

1°) of station staff;

2°) of signalmen;

3°) of level crossing keepers;

4°) of staff engaged on maintenance work on the permanent way and signals.

Compare these numbers if possible with those for the railway as a whole.

To what extent can the number of employees be reduced if the passenger trains are suppressed ?

The information collected is summed up in the preceding table.

As is only to be expected, there are appreciable differences between the figures sent in by the different railways.

These are due essentially to the configuration of the line, the operating conditions, and the nature of the traffic, which are particular to each railway, as well as the distance between stations.

To a lesser degree, differences also occurred in the way the staff were grouped into the various categories.

Nevertheless, as they stand, they make it possible to draw up various interesting deductions :

— the average number of men engaged on clerical duties per km of secondary line is 1.5 (from 1 to 2) compared with 6 (from 5 to 7) for the railway as a whole, i. e. 25 %;

— the suppression of the passenger services on the secondary lines makes it possible to reduce such staff to 0.6 (from 0.5 to 0.7 — except on the Italian Railways);

— the saving in clerical staff due to the suppression of passenger trains on secondary lines — this figure is on the average 0.9 man per km of line — is therefore about 60 % of the corresponding costs.

QUESTION 14. — *What are the wages and average cost on the lines in question, taking every item into account of :*

1°) a station employee;

2°) a signalman;

3°) a level crossing keeper;

4°) an employee engaged on maintenance work on the permanent way or signals;

5°) a steam train kilometre;

6°) a railcar kilometre;

7°) an omnibus kilometre.

The following table gives some idea of the wage position, including all charges and traction costs on various railways.

In spite of various differences due to inevitable mistakes in interpretation, especially as regards the charges to be included, operating conditions and charges, it will be seen that the average annual wage varies between 60 000 and 90 000 Belgian francs.

If we refer to the average saving in staff given under Question 13, we will see that closing down the passenger services results in an average saving of 54 000 to 81 000 Belgian francs per km, as regards the clerical staff alone.

On the other hand we have seen (Questions 1 and 7) that the secondary lines are

Categories of staff	S.N.C.B.	S.N.C.F.	D.B.	F.S.	C.F.L.	N.S.	C.F.F.	Mozambique
a) *Annual salaries in Belgian francs.*								
Station staff	112 300	70 000	58 800	58 500	103 000	53 000	112 700	84 500
Signalman	69 800	—	—	61 200		49 300		
Level crossing keeper	50 800	30 000	50 400	53 900				
Track maintenance man	64 900		45 600	85 700	93 000	50 350		59 100
Signal maintenance man	77 800							
b) *Cost per kilometre in Belgian francs.*								
Steam traction	41.24	63.00	30.00	20.80		23 85		77 44
Railcar	20.02	15.22	15.60	17.60	—	9 28	—	56 32
Motor bus	10.00	10.15	9.60	9.60		6 62	19.03	10 20

on the average run over by 5 000 passenger train-km per kilometre of line.

If we agree that :

— the passenger trains consist of 50 % steam trains and 50 % railcars;

— that the suppression of these trains only leads in practice to a saving of about 75 % of their cost;

— that the cost of the steam train-km given by some railways is too low and certainly does not include the charges and indirect costs which should be taken into account; so that an average cost of 40 francs per steam train-km and 20 francs per railcar-km, i. e. an average of 30 francs per km would be more accurate;

- that the mileage of the substitute bus services would be about 40 % higher than that of the train services they replace (see Question 8) and that they require additional staff to collect the fares, the cost of which will be about 1 franc per km; we can conclude that the organization of a bus service to replace a train service will make it possible to count upon a saving in traction costs per kilometre of line of the order of 7 Belgian francs per train-km ($0.75 \times 30 - 1.4\ (10 + 1) = 7.10$ Belgian francs), or about $5\,000 \times 7 = 35\,000$ Belgian francs per km of line.

The total probable saving will therefore be between 89 000 Belgian francs and 116 000 Belgian francs, or an average of 100 000 Belgian francs per km.

The detailed studies made by the S. N. C. B. for a total of 380 km of lines agree very closely with this figure, since it was 109 000 Belgian francs per km.

We can therefore state that for closing down the train services on secondary lines the following criteria set the limits :

- 5 to 6 000 train-kilometres per annum per km of line;

250 000 traffic units per year per km of line;

- annual saving to be counted on :

a) by substituting bus services for the passenger trains : 100 000 Belgian francs approx. per km of line;

b) by completely closing down the line : 130 000 Belgian francs approx. per km of line.

QUESTION 15. — *When the railway organizes its own omnibus services, which do you think is the best solution and why :*

— omnibus belonging to the railway;

— hired omnibus;

— contract work; state the usual conditions in the case of the latter ?

Opinions are very divided.

The railways authorised to operate bus services themselves, prefer to work such services themselves, i. e. with their own buses.

This solution has many advantages :

— the use of well-designed vehicles giving every guarantee as regards safety and comfort; standardisation of the stock;

— timetables perfectly adapted to the connecting train services;

— facilities from the point of view of the rates and collecting the fares;

— the possibility of absorbing redundant staff as conductors, ticket-collectors and maintenance staff;

— with several bus services running, vehicles from one route can be used on other routes in case of accidents or at peak hours.

Operating by means of hired buses with railway staff has the same advantages as regards the timetables, rates and collection of fares, but has the drawback of having to use various types of vehicles which do not always give all the conditions of safety and comfort which the public expects from the train services. It is however cheaper than the former method (by about 15 to 20 %).

As for operating under contract, this is rarely done in the case of these substitute services : there are a few such cases in France and there is a general tendency in this direction in Italy.

The contract is generally given to the firm making the highest bid (often 5 to 10 % of the receipts) and carries with it an obligation to respect the conditions imposed as regards the timetables and fares.

QUESTION 16. — *What type of omnibus do you prefer ? Give its chief characteristics :*

— number of passengers seated and standing;

— ventilation;

— heating;

— compartment for luggage, express goods and parcels;

— W. C.;

— possibility of carrying bicycles and prams;

— value of having a trailer.

Most of the buses in service can carry 60 to 70 passengers, about half of them seated.

The C. F. F. prefer the smaller type of bus (33 seats and room for 20 standing), no doubt on account of the hilly and winding nature of the roads in Switzerland.

A few railways report the use of small buses (carrying 50 of fewer passengers) on local lines.

But there is a tendency to build larger vehicles for 100 passengers (Italy and the Belgian light railways).

In general the railways agree that the buses should be equipped with a well designed system of ventilation and heating, making them pleasant and healthy to ride in at all seasons of the year.

The S. N. C. B., C. F. F. and Mozambique Railways are in favour of having a luggage compartment. This can consist of a locker at the back or side lockers with a capacity of 1 to 2 cubic metres (35 to 70 cubic feet). They can be used not only to carry luggage but also small parcels, which often saves expensive lorry services.

Certain railways (D. B. and C. F. F.) prefer or make use of two wheeled trailers

for luggage, and these can also be used to carry bicycles.

None of the railways consider it necessary to provide a W. C.

The S. N. C. B., D. B., and C. F. F. will carry bicycles. In Belgium the buses are equipped with a device at the rear which can take 2 or 3 bicycles. There are also arrangement to take them on the roof.

Prams are carried when there is room for them.

Passenger trailers are rare. They will carry 40 to 50 passengers but can only be used when the layout and profile of the road is good and atmospheric conditions favourable.

The use of a trailer obviously makes it possible to reduce the number of runs; it has however the drawback of reducing the speed, and consequently increasing the journey time.

QUESTION 17. — *What amount of luggage, express goods and parcels is carried on these lines?*

Do you think that it can be transported by the bus services?

How are goods collected and delivered to destination? Do you have agencies in places of a certain size for parcels handed in locally and awaiting collection, and how are these services paid for?

Do you limit the times at which goods can be accepted and collected in proportion to the amount of traffic?

Do you run any door to door services, and if so, how?

All the railways agree that the amount of luggage, express goods and parcels is generally very small on the lines in question.

The weight of luggage and express goods is only a few hundred kilos a day.

However the D. B. reports that in certain special cases it may be as much as 1 000 t a year in the case of express goods and 10 000 t a year in the case of parcels. The tonnage depends not only on the places but also naturally on the length of the line: if this does not exceed 30 km, the tonnages indicated by the D. B. are rarely achieved.

In principle, the buses carry luggage, postal parcels and express goods, except in Holland where only papers are accepted.

Parcels are sent by goods train, except in Holland and Belgium where the development of the road services makes it possible to reach every locality by lorry from station-centres on the important lines.

Parcels carried by bus are usually accepted and delivered by means of agents. These can be persons living in the disused station buildings or business firms in the centre of the towns on the bus route. In certain cases, the agents deliver small parcels (less than 15 kg [33 lbs] within a limited radius (1 to 3 km = 0.6 to 1.8 miles).

Railways operating terminal parcels services by means of lorries adopt the same measures as regards the choice of agents.

The way the latter are remunerated varies.

The C. F. L. pay 1 000 to 3 000 francs a month.

The S. N. C. B. lodge them rent free including heating (4 tons of coal a year) and lighting (when they occupy the station) or pay so much per parcel plus the telephone charges.

The S. N. C. V. find it unnecessary to pay their agents, as firms accept the job in order to get additional customers.

Except in the case of business firms, the hours at which the agents offices are open are often fixed according to the traffic and bus timetables.

QUESTION 18. — *What amount of full load traffic is there on the lines in question (tons or wagons per km of lines)?*

— What sort of goods are normally carried?

— Do you think they can all be carried by road (terminal runs) ?

— What methods do you stipulate (tanks, containers, rail-road trailers, wagon carrying trailers, etc.) according to the categories of goods. Can clients be required to use them ?

The number of wagons per line is 1 — or less — to 12 a day.

The traffic generally consists for the most part of coal, manure, agricultural products, building materials and in some districts, timber.

Apart from girders and timber, the transport of which necessitates special stock (special lorries or wagon-conveying trailers), the other products can be carried by road without difficulty in standard types of vehicles (ordinary lorries, containers).

Most of the railways consider however that the terminal road journey costs a great deal more than simply maintaining the line as a simple connection or industrial line. This financial aspect of the question is the subject of Question 22.

On the other hand, they are of the opinion that the public cannot be forced to choose any particular method which facilitates mixed transport.

We do not entirely share this opinion, and we think that there are two quite distinct cases to be considered :

— either the client decides to carry out the terminal transport forced upon him by the closing down of the line for himself, it being understood that the preliminary studies have shown that this closing down is compatible with the layout and length of the road journey, the nature of the goods, the importance of the traffic and the methods of transport belonging to the consignors and consignees.

In this case, he is obviously free to select the railway stock used for the transport, within the conditions imposed by the regulations.

— or the client asks for the terminal transport to be carried out by the railway, including collection or delivery at his premises.

In this case, the railway is obliged to stipulate the use of the most suitable type of railway stock for the combined rail-road journey, in the same way as they can stipulate the type of wagon to be used (open, flat, covered) according to the kind of goods, and adapt the tonnage of the wagon to the size of the consignment.

QUESTION 19. — *If the goods services on a line are suppressed, who will be responsible for tranferring goods from the wagon to the lorry (on arrival) or from the lorry to the wagon (on departure) ?*

What methods of handling do you consider necessary and who is to pay for the handling ?

The few railways, who replied to this question (S. N. C. F., F. S., C. F. L. and S. N. C. B.), expressed the opinion that the necessary loading and unloading operations should be carried out by the railway.

The F. S. and C. F. L. stipulate however that the cost of these operations — at the rates laid down if any — is to be borne by the client.

This seems right to us, in view of the fact that the client is in fact spared this work.

Obviously the question does not arise when the client carries out the terminal road transport for himself.

Transhipment is often done manually.

All the railways agree that it is advantageous to mechanize these operations by the use of cranes, gantries, elevators, belt conveyors, etc.

We might mention in this connection that a study carried out by the S. N. C. B. has shown that the use of pneumatic-tyred cranes in the goods yards is to be recommended. If used full time, for 8 h a day, a 6 t crane does the work for 5 Belgian francs per ton, including all charges; in addition it makes it unnecessary to shunt the wagons to be loaded and unloaded.

QUESTION 20. — *Who will work the terminal road transport services (railway, private firm, consignor or consignee)?*

— If the railway does, what rates will apply to these services?

When clients are able to load or unload wagons in a nearby station on another line, and have sufficient transport available, the closing down of a line does not give rise to any problem.

This is frequently the case on dense systems such as that of the S. N. C. B.

But if this is not so, it is necessary to make provision for sending complete loads by road independently of the client.

Generally, the railway has to organize the road services, at railway rates.

The S. N. C. F. does not do so simply because the present laws oblige them to have the work done by a contractor or by a public transport firm. The new measures to put the S. N. C. F. in a sound financial position, now under investigation, provide that if the conditions offered by the road hauliers do not make it possible to carry out the public services satisfactorily or at railway rates, the S. N. C. F. can be authorised to work such transport itself.

Finally, the public will not suffer financially from the closing down of a line.

QUESTION 21. — *If the railway is responsible for the terminal road transport services, what is its position from the point of view of the responsibility of the transporter (wagon opened when the consignee is not present, goods loaded and stowed by the railway on departure).*

— When does the transport contract begin and end?

— How are the waybills sent?

— How and when are the amounts due estimated and paid?

It is unanimously agreed that the transport contract begins with the acceptance of the goods and waybills and ends when the consignment is delivered. The contract therefore covers the road part of the journey whether carried out by the railway itself or under contract.

The result is that the railway is responsible for any damage done during loading or unloading, or due to faulty stowing or poor loading of the wagons.

No replies were received about damage attributable to insufficient packing and claims for short deliveries.

On departure, the documents are handed to the haulier, but the acceptance and payment takes place at the transhipment station. If the consignment is being sent carriage paid, the haulier collects the amount due on his next run and hand over the duplicate waybills, unless the client has an account with the railway.

On arrival, if the consignment is being sent carriage forward, the charges are again collected by the haulier.

QUESTION 22. — *What will these road services cost?*

How does this compare with the savings expected from the complete closing down of the line (operating costs, capital and sinking fund charges) taking it that the passenger services have already been suppressed and the corresponding savings realised?

1) *Road service cost.*

Terminal road transport of full loads can be effected by one of the following methods of transport

— ordinary lorries (generally 4 to 5 t useful load);

— containers (up to 5 t useful load);

— rail-road trailers (U. F. R. type of the S. N. C. F. or similar);

— wagon conveying trailers.

No railway supplied any information about the cost of such road services.

We are therefore obliged to rely entirely on the studies and results recorded on the S. N. C. B.

We will consider the concrete example of 10, 20 and 30 km long lines (average transport distances 5, 10 and 15 km, with wagons having an average load of 15 t).

a) *Use of ordinary lorries.*

The cost is 65, 75 and 85 Belgian francs per tonne, respectively for the above three lengths of line, including transhipment from wagon to lorry and vice versa.

In the case of a 15 t wagon this represents a cost of 975, 1 125 and 1 275 francs respectively.

As the client no longer has to carry out the transhipment of the goods nor the haulage between the nearest station and his premises, the railway is obliged to increase the transport charges — which remain unchanged — by the cost of these services which can be estimated as 25 francs per t, i. e. 375 francs per wagon.

Loss to the railway :

10 km line . . . . 600 francs per wagon;
20 km line . . . . 750 francs per wagon;
30 km line . . . . 900 francs per wagon.

b) *Use of 5 t containers.*

The cost, including the cost of the return journey empty, is as follows :

— 10 km line : average transport distance : 5 km :
open container . . . 25 fr./t or 375 francs per wagon;
closed container . . 35 fr./t or 525 francs per wagon;

— 20 km line : average transport distance : 10 km :
open container . . . 40 fr./t or 600 francs per wagon;
closed container . . 50 fr./t or 750 francs per wagon;

— 30 km line : average transport distance : 15 km :
open container . . . 55 fr./t or 825 francs per wagon;
closed container . . 65 fr./t or 975 francs per wagon.

Handling at the station (from the wagon onto to the trailer or vice-versa) is easier and quicker and does not require any special lifting tackle, so that the cost of this operation and delivery or collection can be estimated at 20 fr. per t, or 300 fr. per wagon.

Loss for the railway :

— 10 km line : open containers . . . . . 75 francs per wagon;
closed containers . . . . . 225 francs per wagon;

— 20 km line : open containers . . . . . 300 francs per wagon;
closed containers . . . . . 450 francs per wagon;

— 30 km line : open containers . . . . . 525 francs per wagon;
closed containers . . . . . 675 francs per wagon.

c) *Use of rail-road trailers.*

We have had no experience at all of such vehicles on the Belgian Railway system.

d) *Use of wagon-conveying trailers.*

We have taken as a basis an average hourly speed of 15 km and an average run empty of 50 % of the loaded run.

Under these conditions, the total run per wagon for each of the three categories of lines considered is 15, 30 and 45 km (9, 18 and 28 miles) and the output of a group consisting of tractor and trailer of 4, 3 and 2 wagons per 8 h working day.

The costs are respectively 375, 620 and 880 francs per wagon, from which must be deducted 300 francs as in case *b)* above.

Loss for the railway :

— 10 km line . . . 75 francs per wagon;
— 20 km line . . . 320 francs per wagon;
— 30 km line . . . 580 francs per wagon.

These results show that the use of ordinary lorries is appreciably more costly than the use of containers or wagon-conveying trailers the cost of which is very similar.

These is due essentially to the time lost by the staff and rolling stock during the relatively long time it takes to load and unload.

Costs can be reduced by making use of lifting tackle and suitable rolling stock, so long as the lifting tackle is fully utilised.

In our opinion, large containers and wagon-conveying trailers will always have an appreciable advantage economically, whilst avoiding handling the goods an extra time, a frequent cause of damage. They are also more generally used.

2) *Saving due to closing down the goods services.*

The studies made on the Belgian Railways have led us to this conclusion, that, compared with the total saving due to completely closing down a line, the suppression of the passenger services and replacing them by a bus service will of itself lead to a saving of 75 % of the total amount saved, the closing down of the goods services only making a saving of about 25 %.

We saw above (Question 14) that the annual saving obtained by closing down the passenger services is about 100 000 Belgian francs per km.

The closing down of the goods services will therefore result in an annual saving of about 30 000 Belgian francs per km.

The saving to be expected by sending full loads by road, for the 3 categories of lines considered under 1) will therefore be 300 000 fr., 600 000 fr. and 900 000 fr.

3) *Limited traffic.*

We can therefore define the limit of traffic below which carrying out the terminal transport by road is economical, taking as the average cost per wagon 75 fr., 350 fr. and 600 fr.

— 10 km line : $\frac{300\,000}{75 \times 300} = 13$ wagons a day;

— 20 km line : $\frac{600\,000}{350 \times 300} = 6$ wagons a day;

— 30 km line : $\frac{900\,000}{600 \times 300} = 5$ wagons a day.

QUESTION 23. — *What authority can decree the closing down of an existing line and what arguments are generally taken into account in order to justify this step?*

If in spite of the definite economic advantages, political or military reasons are against the closing down of a line, is it the practice to subsidize the operator?

In all countries, the complete closing down of a line must be authorised by the Government, it even being necessary to pass a law to this effect.

The arguments taken into consideration are economical and political in nature, and in some cases military.

From the economic point of view, the essential factor consists in comparing the cost by road and by rail as regards the terminal transport.

This must be definitely in favour of the road services if the closing down of the line is to be upheld.

However political reasons, which government circles alone can judge, may justify the retention of the line : this would be the case for example in districts with only a poor road network, either as regards density or condition.

Military reasons can also be against the closing down of a line, although local lines are rarely of strategic importance.

If for one or other reason the Government cannot look with favour on a suggestion to close down a line put forward

by the railway, the latter is not as a rule compensated. The C. F. L. and the Algerian Railways report however cases in which subsidies have been granted for lines they were not allowed to close down.

QUESTION 24. — *If the local goods traffic cannot be carried by road (taking it that the passenger services have already been suppressed) do you consider that the line should be kept open, or should it be operated simply as a connecting or industrial line?*

In the latter case, how will it be operated, what staff and installations will be retained, and how will clients be kept in touch with?

Opinions are generally in favour of operating the line as an industrial line or siding.

In both cases, a shuttle service will be used, from one of the stations at the end of the line.

There will no longer be any staff or signals on the line.

The station at the head of the line becomes the operating station; it draws up the charges and advises clients by telephone, or else the agent of the locality in question who is reponsible for advising clients of the arrival of wagons.

The rake is accompanied by a trained employee, who carries out the operations of accepting or handing over consignments, either to the clients or to the agent.

Payment is made by money order by post or by credit accounts with the operating station.

Only the C. F. L. are in favour of the line being retained as at present when the goods traffic continues to be transported by rail.

CONCLUSIONS.

1) The modernization of road transport methods and the conditions under which they are now operated makes it more economic to send the small traffic of some local railway lines by road.

However, such a switching over of part of the railway traffic — the inevitable consequence of the free competition of the road — implies that the road transport services are completely able to deal with the traffic and will be able to do so in all circumstances.

The responsible authorities must therefore see to it that the roads are usable at all times, as railway operators have to do.

2) The closing down of a line requires Government authorisation. This is generally subordinated to a favourable balance-sheet being obtained, the railway tariffs continuing to apply.

3) The partial or total closing down of railway services can be considered in the case of lines on which the annual number of train-kilometres per km of line does not exceed 6 000 or the number of traffic units per km of line about 250 000.

4) There is no set ratio between the reduction in the costs consequent upon the closing down of a line and the cost of working it.

It is recommended that the saving should be determined by a comparison of the real economies and cost of the road services.

If the railway assures the road services, there will not be any appreciable drop in the receipts.

The savings to be expected are on the average of the order of 130 000 Belgian francs per km, 100 000 fr. of which are the result of replacing the passenger trains by bus services. These figures suppose that the receipts remain unchanged.

5) It is advantageous both for the public and the railway, if the railway itself is authorised to operate the replacement services itself.

The public thereby receive a guarantee of safety, comfort and good connections; the railway, a continuance of its receipts.

6) Bus services are generally liked by the public, especially when they run right into the towns and the railway rates remain unaltered.

The daily mileage will be 30 to 50 % higher than the train mileage owing to limited capacity of the buses and the need for running reliefs at peak hours.

Trailers are rarely used; they require very strict conditions as regards layout, profil and width of the roads.

7) It is recommended that the tickets sold on the buses shall be for the bus journey only.

Arrangements can be made if necessary to avoid any increase in the total cost of the journey when this is continued by rail.

The easiest way to adapt the railway rates to the road journey is to divide up the run into sections, the end of each of which can be approximated to a neighbouring station.

8) The buses should be sufficiently comfortable, particularly as regards heating and ventilation.

Lockers should be provided to take luggage, express goods and parcels and small goods when this traffic is too small to justify the organization of a haulage service.

Local agents are responsible for accepting and delivering consignments.

It is a useful practice to equip the buses with some device to carry 2 or 3 bicycles.

9) The suppression of the goods trains and closing down of a line can only be considered if clients are able without an excessive increase in the length of the journey to load or unload their goods at another station, or if the railway can work the terminal services by road without the additional cost involved wiping out the saving so made.

In the latter case, it is best to make use either of large containers or similar methods or wagon-conveying trailers.

This is only profitable if the traffic is relatively small (a maximum of 13 wagons a day for a 10 km (6 miles) long line, 6 wagons for a 20 km (12 miles) line and 5 wagons for 30 km (18 miles) line).

10) When the railway makes itself responsible for the terminal transport by road of full loads to clients' premises or collects them from the latter, it should charge for collection and delivery over and above the standard rates.

11) The railway is responsible for the transport from one end of the journey to the other, including any transport by road if this is worked by the railway itself or by contract.

12) If the traffic is greater than indicated under conclusion 9, it is better to keep the line open for goods traffic, and run it on the lines of a siding.

* * *

b) Construction of new railway lines.

QUESTION 25. — *Have you built any new lines during the last few years or do you propose to build any in the near future?*

— How long are they?

- What reasons (financial, economic, political or military) have justified their construction?

— If any operating balance sheet was drawn up as a preliminary please give the essential factors.

Generally, the European Railways are no longer considering the construction of new railway lines, the existing lines being sufficient to meet industrial, commercial and social needs.

In Europe, Spain alone has any railway building programme but though this is being carried out, no details were given.

On the other hand, several African Railways (Algeria, Morocco, Mozambique, Angola) are at present carrying out a programme for the construction of new lines. These are lines running inland into the country to serve mining or agricultural interests, the expected traffic being of the order of 1 million tons a year. No preliminary balance sheets have however been prepared, as these lines were considered essential for the economic development of

the regions concerned even if it will be difficult to operate them at a profit the first few years.

QUESTION 26. — *In your opinion, what is the minimum annual tonnage of goods traffic that can be counted on and what peak traffic that will justify the construction of a new line.*

When making the preliminary studies, do you consider that the traffic can be carried by road alone or by a combination of rail and road services, both at the present time and in the future?

No railway supplied any interesting details in reply to this question.

Some of them merely contented themselves with saying that the general principle was that the cost per tonne-kilometre should not exceed the average receipt per tonne-kilometre of the system.

But in actual fact, this merely sets the question in another form since to determine the cost of the tonne-kilometre on a new line, it is necessary to know the capital to be invested, the operating costs and the traffic expected.

On the other hand, the French and Belgian railways consider that rather than build new lines it is better to complete the existing railway system by means of connecting road services collecting the secondary traffic from outlying parts towards the centre stations. This organisation is now being realised.

We arrived at the same conclusion in the first part of this report, so long as the traffic is below a certain level.

QUESTION 27. — *What will be at the present time the average cost per kilometre of a single track line having the characteristics — as detailed — laid down for your secondary lines (for example : 300 metres minimum radius curves; maximum gradients of 15 °/₀₀).*

Give in particular the cost per kilometre :

1°) of the studies and layout;

2°) of acquiring the site;

3°) of the work involved in making the bed (embankments, drainage, etc.);

4°) of bridges;

5°) of laying the track — both the running road and sidings — including the ballast;

6°) of the signal installations;

7°) of the buildings;

8°) of the telephone and lighting installations, etc.

The replies received show that the estimates per kilometre of line for various grades of work and types of construction vary a lot from one railway to another, the total average cost at the present time of a kilometre of new line in Europe is about 6 million Belgian francs, except in very hilly countries such as Switzerland where it is as much as 13 million Belgian francs.

In Africa on the other hand, for the usual colonial line of 1.067 m (3′ 6″) gauge, the cost in 1949 was about 3 million Belgian francs per kilometre, but this figure should be increased at the present date by about 20 %, i. e. 3.6 million Belgian francs.

QUESTION 28. — *In the case of a new line, 100 km long, with various values for the hypothetical traffic distributed evenly throughout the year, ranging between 10 000 and 1 000 000 tons per year, what will be the cost of the tonne-kilometre, taking into account :*

— the cost of working similar lines;

— the capital and sinking fund charges corresponding to the investments detailed in Question 27.

As no complete replies were received, we think it interesting to sum up here, and under Question 30 the conclusions arrived at from a very thorough study carried out in connection with the Belgian Colonial Services and published under the title : « *Ten year plan for the economic and social development of the Belgian Congo* ».

Traffic		Capital	Annual charges (in 1 000 B. fr.)				Traffic-km units in 1 000 km units	Cost of the km units in B. fr.
Goods in 1 000 t	Passengers in 1 000 passengers	Fixed installations and rolling stock in millions of B. fr.	Financial	Operating	Renewals	Total		
10	1.70	1 628	82 055	17 983	16 130	116 168	5 850	19.86
20	2.72	1 649	83 114	20 607	16 535	120 256	11 360	10.59
30	3.74	1 676	84 475	22 893	17 055	124 423	16 870	7.38
40	4.76	1 702	85 785	25 424	17 560	128 769	22 380	5.75
50	5.76	1 730	87 196	27 183	18 105	132 484	27 880	4.75
60	6.86	1 760	88 708	29 486	18 685	136 879	33 430	4.09
70	7.96	1 790	90 220	31 574	19 265	141 059	38 980	3.62
80	9.06	1 819	91 682	33 220	19 825	144 727	44 530	3.25
90	10.16	1 849	93 194	35 457	20 405	149 056	50 080	2.98
100	11.26	1 877	94 605	37 328	20 905	152 838	55 630	2.75
110	12.38	1 902	95 865	39 284	21 500	156 649	61 190	2.56
120	13.50	1 925	97 025	41 118	22 065	160 208	66 750	2.40
130	14.64	1 950	98 285	43 175	22 650	164 110	72 320	2.27
140	15.76	1 974	99 495	45 015	23 220	167 730	77 880	2.15
150	16.88	1 998	100 704	46 643	23 805	171 152	83 440	2.05
175	19.70	2 059	103 779	51 985	25 235	180 999	97 350	1.86
200	22.50	2 119	106 803	55 514	25 675	187 992	111 250	1.69
250	28.13	2 228	112 297	63 833	29 080	205 210	139 070	1.48
300	33.76	2 337	117 791	72 092	31 450	221 333	166 880	1.33
350	39.38	2 446	123 284	79 434	33 850	236 568	194 690	1.22
400	45.00	2 556	128 829	88 555	36 240	253 624	222 500	1.14

The object of this study was to determine, for various amounts of traffic, the cost of the tonne-kilometre by rail and by road, and thereby determine at which level of traffic the road is more economic than the railway.

From the point of view of the problem with which we are concerned, this study is all the more interesting in that, according to the opinions of the railways consulted, the construction of new railways hardly comes into the picture except in new countries like the Belgian Congo.

It would however be easy to apply these same conclusions to European railways, taking into account the fact that in this latter case the capital invested in the railway would have to be increased by about 66 % (6 million francs per kilometre in Europe as against 3.6 millions francs in Africa) and the operating costs by 47 % (0.808 Belgian fr. per tonne-km in Europe compared with 0.55 Belgian fr. in Africa — figures for 1947 — for the Matadi-Léopoldville line : length 366 km (227 miles), traffic 1 million t per annum).

In the case of the railway, this study was carried out on general lines, in connection with a line having the following characteristics :

— 1.067 m (3′ 6″) gauge track, with 30 kg (66 lbs.) rails and 1 500 metal sleepers per kilometre;

— minim. radius of curves 200 m (656 feet);

— maximum gradients : 15 ‰.

The financial charges included :

— interest on capital at 5 %;

— capital repayment in 99 years;

— uniform division of these two charges over 99 years, i.e. 5.040245 % of the capital annually.

The cost of the traffic-km unit was calculated for various amounts of passenger and goods traffic (the latter varying between 10 000 and 400 000 t a year), taking it that such traffic was carried the entire length of the line.

The preceding table shows in terms of the variation in the traffic the amount of the capital invested, financial charges, operating costs and renewal costs, and finally the cost of the traffic-km unit.

The predominating part played by the financial charges (70.6 % for a goods traffic of 10 000 t, 50.8 % for 400 000 t) in the cost of the traffic-km unit will be seen at once.

If only the operating and reneval costs are taken into account, the cost of the traffic-km unit varies from 5.84 fr. to 0.56 fr.

The total unit costs are shown in the following graph. We will compare these later on with the cost of road transport.

QUESTION 29. — *At the present time what would be the average cost per kilometre of a 6 metres wide road with maximum gradients of 5 %.*

In particular give the cost per kilometre of :

1°) studies and layout;

2°) acquiring the site;

3°) work of making the bed (embankments, drainage, etc.);

4°) bridges;

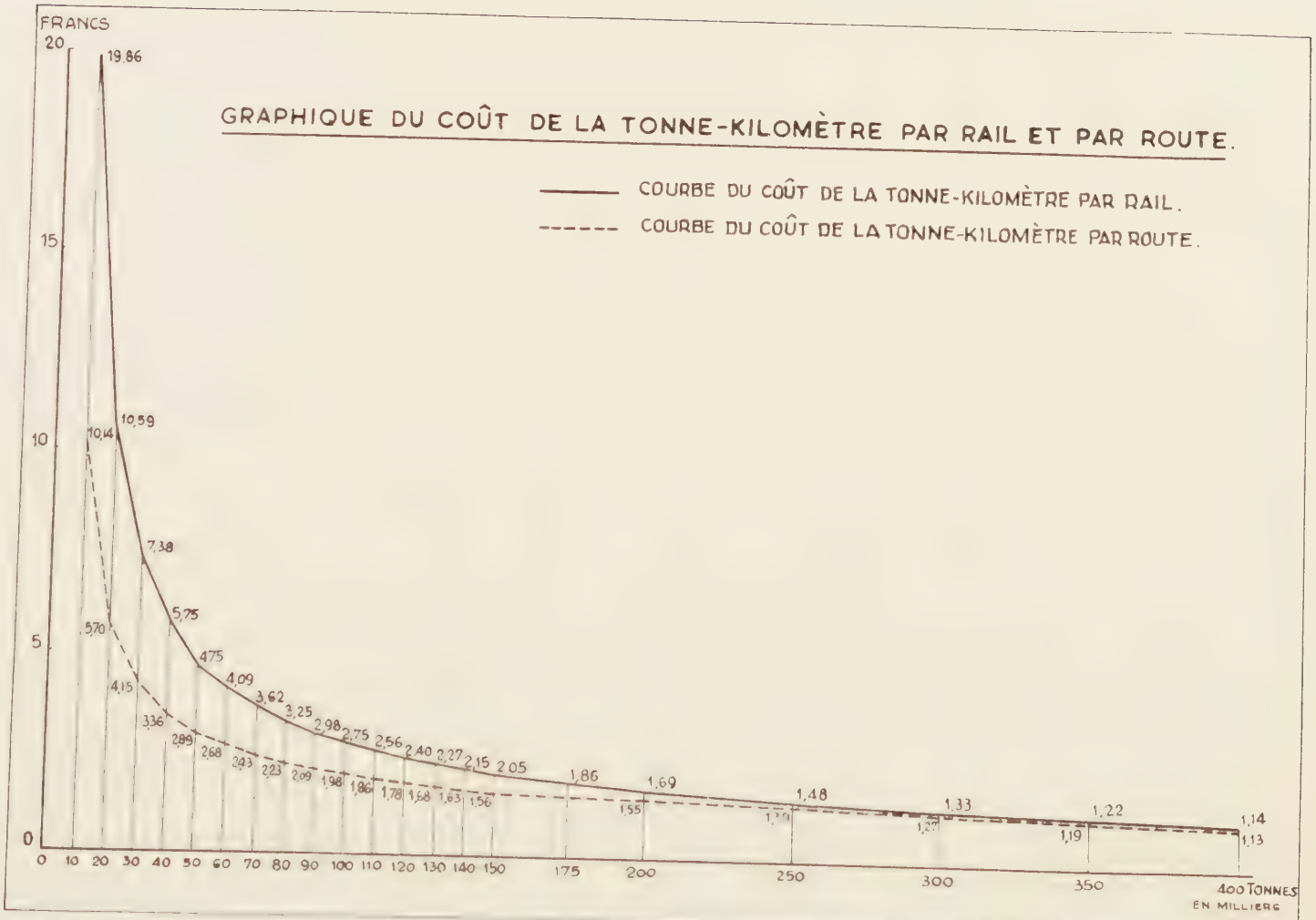
5°) the foundations; } *for various types*

6°) the surfacing } *of road.*

The information received varies considerably from one country to another. There is nothing surprising in this when we remember that the cost of buying the land and making the permanent way and structures can be influenced by the density of the population (costly requisitions), the configuration and the kind of soil.

It can however be concluded that in Europe the construction of a modern 6 m (19′ 8 1/4″) wide road, with maximum gradients of 5 % costs 4 to 8 million Belgian francs.

The « *Ten year plan for the Belgian Congo* » mentioned above, makes a point



Graphique du coût de la tonne-kilomètre par rail et par route = graph of the cost per tonne-kilometre per rail and per road. — Courbe du coût de la tonne-kilomètre par rail = curve of the cost per tonne-kilometre per rail. — Courbe du coût de la tonne-kilomètre par route = curve of the cost

of the varying cost in 1949, between 1 200 000 francs and 2 500 000 francs according to the kind of surface.

At the present times these costs should be increased by at least 20 %.

QUESTION 30. — *In the case of a 100 km long road of the type described above, with various hypothetical values of traffic distributed evenly throughout the year, ranging from 10 000 to 1 000 000 tons per year, what will be the cost of the tonne-kilometre, taking into account :*

— the maintenance costs of similar roads;

— the capital and sinking fund charges corresponding to the investments detailed under Question 29;

— the cost of motor traction, taking it that the lorries and trailers used can carry (lorry plus trailer) 20 ton loads.

The replies received from some European railways are incomplete and so contradictory regarding the costs given, that we are convinced that they cannot have been based on similar conditions, nor gone into in detail.

We are therefore referring once again to the study of road transport in the above mentioned « *Ten year plan* ».

These were concerned with determining the cost of the traffic-km unit on a 6.60 m (21′ 7 7/8″) wide road with maximum gradients of 5 %.

Three types of surface were considered according to the amount of traffic expected annually :

— A surface : 0.15 m (5 29/32″) thick concrete on a rubble foundation 0.50 m (1′ 7 11/16″) thick (traffic $\geqslant$ 200 000 t);

— B surface : foundation of rubble and small stones covered with a layer of asphalt (traffic $\geqslant$ 60 000 t);

— C surface : gravel covered with a layer of asphalt (traffic $<$ 60 000 t).

The total cost of roads of this kind (1949 prices) are respectively 2 500 000 francs, 1 500 000 francs and 1 220 000 francs per km.

The capital investment covers in addition to the fixed equipment, the necessary rolling stock including lorries and service and breakdown vans.

Just as in the case of the calculations for the railway traffic-km unit, the financial charges amount to 5.040245 % of the capital annually.

Provision is made for renewal of the lorries after 600 000 km (373 000 miles) and for motorcars after 300 000 km (186 000 miles).

The traffic is supposed to run the entire length of the road, but the number of vehicles required has been estimated on unequal traffic in the proportion of 16/26 in one direction and 10/26 in the other.

The results of these calculations for various amounts of traffic are summed up in the table on the next page.

The figures in parentheses in the last column refer to the cost of the actual transport (financial, operating and renewal of rolling stock and staff). The costs are appreciably higher than those arrived at in a very detailed investigation carried out by the S. N. C. B. which we reproduce for information :

annual traffic of 10 000 t cost per tonne-kilometre : 0.926 fr.;
annual traffic of 50 000 t cost per tonne-kilometre : 0.805 fr.;
annual traffic of 100 000 t cost per tonne-kilometre : 0.798 fr.;
annual traffic of 250 000 t cost per tonne-kilometre : 0.779 fr.;
annual traffic of 500 000 t cost per tonne-kilometre : 0.772 fr.;
annual traffic of 1 000 000 t cost per tonne-kilometre : 0.769 fr.

Traffic			Capital	Annual charges (in 1 000 Belgian francs)				Traffic-km units in 1 000 km units	Cost of the km units in Belgian francs
Goods in 1 000 t	Passenger in 1 000 passengers	Type of road surface	Fixed installations and rolling stock in million Belgian francs	Financial	Operating	Renewal	Total		
10	1.68	C	635	32 020	13 260	13 975	59 255	5 840	10.14 (1.64)
20	2.68	C	650	32 760	17 310	14 585	64 655	11 340	5.70 (1.32)
30	3.68	C	665	33 560	21 025	15 205	69 790	16 840	4.15 (1.20)
40	4.68	C	681	34 330	24 965	15 885	75 180	22 340	3.36 (1.14)
50	5.68	C	697	35 120	29 025	16 505	80 650	27 840	2.89 (1.11)
60	6.77	B	851	42 900	29 630	17 100	89 630	33 380	2.68 (1.03)
70	7.86	B	867	43 720	33 085	17 740	94 545	38 930	2.43 (1.01)
80	8.95	B	882	44 460	36 475	18 380	99 315	44 470	2.23 (0.99)
90	10.04	B	898	45 250	40 260	19 010	104 520	50 020	2.09 (0.99)
100	11.13	B	914	46 080	44 050	19 800	109 930	55 570	1.98 (0.99)
110	12.24	B	924	46 600	47 180	20 310	114 090	61 120	1.86 (0.96)
120	13.35	B	935	47 130	50 315	20 780	118 225	66 670	1.78 (0.95)
130	14.46	B	945	47 660	53 595	21 350	122 605	72 230	1.69 (0.93)
140	15.58	B	956	48 190	56 700	21 860	126 750	77 790	1.63 (0.92)
150	16.69	B	966	48 670	59 385	22 350	130 405	83 350	1.56 (0.90)
200	22.25	A	1 518	76 530	70 868	24 750	172 148	111 120	1.55 (0.84)
250	27.81	A	1 570	79 120	85 606	27 260	191 986	138 910	1.39 (0.82)
300	33.38	A	1 622	81 770	99 872	29 880	211 522	166 690	1.27 (0.80)
350	38.94	A	1 674	84 390	114 838	32 520	231 748	194 470	1.19 (0.79)
400	44.50	A	1 727	87 060	129 628	35 090	251 778	222 250	1.13 (0.78)

The influence of the financial charges of the cost of the traffic-km unit is 54 % in the case of a traffic of 10 000 t and 34.5 % for 400 000 t. It is therefore appreciably lower than in the case of a railway, hence the advantage of the road in cases of little traffic.

The unit costs shown in the table are also given in the form of a graph on page 172/26.

A comparison with that for railway transport shows that the two curves practically coincide when the traffic amounts to 350 000 to 400 000 t a year.

In Europe, the two curves join at a slightly lower traffic level as the capital cost of a railway and a road are very much the same, whereas in Africa the road costs the less.

The method of calculation given above can be adapted to the exact costs in each case.

It can however be concluded that when the traffic is about 350 000 t a year, the railway is more economic than the road.

QUESTION 31. — *What is the amount of the fixed charges falling upon full loads sent by rail or by road?*

There were no replies from which anything of interest could be drawn unless — as everyone knows — it is that the railway's fixed costs are appreciably higher than those of the road, as the road transport services only pay in taxation a small part of the maintenance costs of the fixed installations.

The advantage held by the road for short distances is sufficiently well known so that there is no need to insist on this point.

QUESTION 32. — *Apart from the conclusions resulting from a financial balance sheet, are there any other reasons why the railway is interested in making a new railway line, even if the financial results of such a line do not appear to be favourable when taken on their own? For example, should not possible additional receipts due to the carrying over of this new traffic onto existing lines also be taken into account, and how should this be done?*

All the railways agree that the feeder traffic any new line is likely to bring in must be taken into account, but none of them makes it clear how this is to be taken into account in the balance sheet.

The S. N. C. F. report that the new line may also have to be credited with economies in carrying traffic in transit when it is profitable to send this by the new line.

The African Railways confirm that as far as they are concerned, the resultant increase in the value of certain industrial and agricultural regions may justify the construction of a new line, quite apart from the financial returns.

We think however that the study carried out in the case of the Belgian Congo deserves careful preliminary examination, in such cases, in order to avoid any technical mistakes which would fall heavily on the new lines.

CONCLUSIONS.

1) The construction of new railway lines can only be justified in Europe very exceptionally.

2) In new or insufficiently developed countries, the construction of new railways is only justified when the traffic is at least 300 000 to 400 000 t a year.

If the traffic is less than this, the transport can be carried out more economically by road, so long as these are sufficiently good to carry heavy lorries with trailers.

[625 .162 & 656 .254]

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(STOCKHOLM, 1952.)

QUESTION I.

A. — What are the new safety measures taken for level crossing of railway tracks by the road in respect of the density, high tonnage and speed of the road traffic?

In particular automatic signalling and closing of level crossings without keepers, worked by the trains themselves.

Technical and statistical investigation in order to ascertain the relative safety of :

1° level crossings with keepers, with the different devices to announce the arrival of the train to the keepers;

2° level crossings without keepers :

a) without any self-acting device announcing the arrival of trains;

b) with automatic signalling for the road-users;

c) with automatic signalling completed by half- or entire gates.

B — Cases of level crossing of railway tracks by a road with a railway (urban or suburban) running alongside.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, China, Ceylon, Egypt, India, Irak, Iran, Irish Free State, New Zealand, Pakistan, South Africa, Sudan, United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible),

by G. MATTHEWS, C. V. O., C. B. E.
Operating Superintendent, Western Region, British Railways,
and S. WILLIAMS,
Signal & Telecommunications Engineer, London Midland Region, British Railways.

Introduction.

A report on the protection of level crossings in view of modern developments in road traffic was made by the late A. NEWLANDS Esqr., Chief Engineer, London Midland and Scottish Railway, at the 12th Session of the International Railway Congress Association at Cairo in 1933.

We do not propose again to go over the ground covered by Mr. NEWLANDS'

report but, as far as possible, to concentrate on developments which have taken place since that time in the devices and regulations for protecting rail and road traffic using level crossings of railways by the roads.

It is important, however, when considering this question, that level crossings be divided into two main sections, viz :

(a) *Public level crossings,* where roads maintained at the expense of the community cross the railways, with an obligation on the part of the railway authority that all the road users will be able to cross over the permanent way and be able to do so in safety;

(b) *Private level crossings,* where there is a restricted user of the road or pedestrian crossing limited to the occupiers of property or their employees, where the property has been severed by the railway, to get access to land on each side, or alternatively to get access from a public road to private property where the railway intervenes. The precautions to be taken to assure the safety of the crossing is generally the responsibility of the user.

It should be noted that Mr. NEWLANDS' report did not deal with the problems arising in connection with the crossings included in (b). In view of the serious difficulties now encountered due to the development of the user of these types of level crossing, especially on British Railways, this report will deal with the problem at some length.

A questionnaire was circulated to Railway Authorities affiliated to the International Railway Congress Association in various countries, and we are charged with the task of summarising the replies received. The countries who have replied to the questionnaire are : Egypt, Eire, Great Britain, India, New Zealand, Rhodesia, South Africa and United States of America.

We have considered it necessary also to include some information, gleaned from other sources, of the modern practices in the U. S. A.

The report is drawn up under three, main heads, viz :

I. Public road level crossings;

II. Private road level crossings;

III. Level crossing of railway tracks by a road carrying a running railway (urban or suburban).

with sub-headings as necessary.

I. Public road level crossings.

(a) *Growth in the number of public level crossings and the user thereof.*

At the outset we would make a general observation in regard to the growth in the number of level crossings and in the traffic (rail and road) using the crossings. The intervention of World War II 1939-1945 restricted development in many of the countries contributing to this report so that, since the Cairo report of 1933, there has been no great variation in the number of public road level crossings to that then given. A complete comparison cannot be made as some of the countries are not now contributors to the statistical information made available in 1933 e.g. China, Japan, etc.

As to the user of public road level crossings by road vehicles, it is axiomatic that this has increased commensurately with the growth in the number of road vehicles since 1933 and there has been a change in the type of vehicles which, generally speaking, are larger and heavier and therefore present a greater danger to rail traffic in the event of collision. Some information indicative of the use of the roads by motor vehicles in some of the countries to which this report applies has been extracted from *Basic Road Statistics* issued by the British Road Federation, dated 1951, and is given hereafter.

It is to be noted that an exact comparison of the density of traffic in different countries is complicated by local variations in the definition of what constitutes a road.

The number of motor vehicles of *all*

COUNTRY	Motor vehicles (*)	Road mileage	Motor vehicles per mile
Great Britain	3 231 000	183 800	17.6
U. S. A.	48 058 000	3 009 000	16.0
Egypt	76 000	10 800	7.0
Union of South Africa	597 000	171 700	3.5
India	275 000	239 100	1.2
New Zealand	323 000	77 100	4.2
Australia	1 358 000	528 200	2.6

(*) Motor cycles and agricultural tractors are not included.

descriptions in use in Great Britain has increased from 2 285 386 in 1933 to 4 409 223 in 1950.

There has been no great variation in the *rail* traffic over the public road level crossings since 1933.

(b) *Laws and regulations applicable to public road level crossings.*

The position in regard to the Laws and Regulations applicable to public road level crossings of railways in the various countries contributing to this report was fully dealt with in Mr. Newlands' report to the Congress for the Cairo Session of 1933 and we have been unable to find any material alteration in the position as it then was.

(c) *Statistics relative to accidents.*

Tables shewing the number of accidents at level crossings in Great Britain for the year 1950 and in the U. S. A. for the years 1947-50 is given in Appendices I and II of this report.

(d) *Traffic factor.*

In order to appreciate the risk of accident at a level crossing, it has been suggested that consideration be given to the idea of introducing a *traffic factor* defined as the product of the average number of railway movements over a level crossing during 24 hours and the average number of vehicles, teams and droves using the roadway over a level crossing during the same period.

If such a record is obtained for every level crossing it is considered that it can then be ascertained which type of protection is the most desirable for any particular level crossing according to the traffic factor as the result of experience on the various railways.

The proposition is that a classification should then be prepared of the types of protection most desirable for a variety of *traffic factors* within a given range which might be enumerated as Categories A, B, C, etc., for the guidance of the railway undertakings.

The replies received from the various countries, however, are mainly *not* in favour of the idea of obtaining a *traffic factor* for level crossings and it is pointed out by one correspondent that experience has shewn that the less busy level crossings are usually the ones at which accidents occur. It is necessary also to take into consideration factors other than traffic

APPENDIX I.

Statistics of level crossing accidents — Great Britain — Year 1950

Category of level crossings	Number of level crossings	Number of accidents		Number of persons involved		Category of persons involved			
		Total	Involving casualties	Killed	Injured	Passengers	Railway servants	Occupants of road vehicles	Pedestrians
Public :									
with gates	4 080	151	22	13	12	—	2	11	12
without gates	370	10	7	1	7	—	—	6	2
Private	22 600	66	28	15	33	4	4	32	8
Footpath	(unknown)	8	8	6	2	—	—	—	8
Total 1950		235	65	35	54	4	6	49	30
Average for years 1946-1950		233	66	43	51				

APPENDIX II.

Rail-highway grade-crossing accidents in U. S. A. in the years 1950-47.

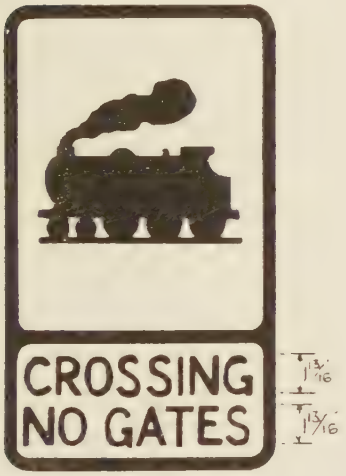
CAUSE OF ACCIDENT	NUMBER OF ACCIDENTS				PERSONS : KILLED				INJURED			
	1950	1949	1948	1947	1950	1949	1948	1947	1950	1949	1948	1947
Trains striking or being struck by :												
Pedestrians	212	228	284	324	141	154	190	216	73	79	96	114
Passenger automobiles	2 777	2 383	2 617	2 571	1 076	964	1 042	1 170	3 331	2 800	3 115	2 999
Motor buses	16	21	23	24	7	23	2	6	73	124	87	101
Motor trucks	869	767	903	974	310	320	311	345	802	683	852	955
Motor cycles	34	38	49	39	17	16	24	15	20	29	38	31
Bicycles	16	20	22	26	10	7	10	18	7	13	13	8
Trolley Cars	1	1	4	3					2	1	14	2
Animal-drawn vehicles	7	13	12	8	3	5	7	3	5	9	8	5
Other vehicles or machines	28	18	23	20	9	7	16	11	17	13	15	18
Pedestrians passing over or under cars	11	7	11	6	2	2	3	1	9	5	8	5
Miscellaneous	29	27	16	20	1	9	7	5	29	18	9	13
Total	4 000	3 523	3 964	4 015	1 576	1 507	1 612	1 790	4 368	3 774	4 255	4 251

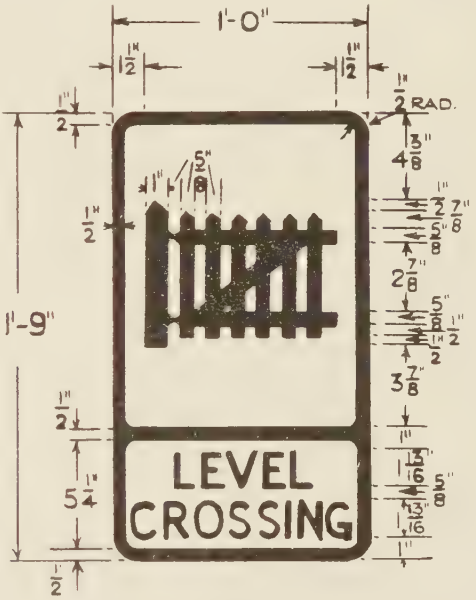
density e.g. gradients of railway and road, visibility of the crossing by drivers of road vehicles and trains, etc.

On the whole, however, we consider that the suggestion is one worthy of further consideration but would suggest that instead of an overall picture covering 24 hours it would be more practical to give the *traffic factor* for a peak period, as it can be readily visualised that whereas during the night hours the *traffic factor* at a particular level crossing may be negligible, during the busy daytime hours the *traffic factor* over the same crossing may be very high indeed.

(e) *Standard road signs indicating approach to a public road level crossing.*

It appears to be the general practice to provide road signs to warn road users of the presence of a public road crossing over a railway. In many cases an advance sign is erected 100 yards or more from the crossing, followed by a second sign in close proximity to the level crossing. In other cases only one sign is provided on the approach side of the level crossing and the distance of this sign from the railway varies in different places. The cost of providing these signs is usually the responsibility of the Road Authority. Opinion is unanimous that road signs of this nature are efficacious in reducing accidents at level crossings and their provision should be encouraged. Illustrations of the types of road signs at present in use in Great Britain are given.





(f) *General.*

The question is asked whether the increase in road traffic justifies a revision of constituted practice about safety at public level crossings but in general there have been no altered conditions to warrant a departure from the accepted methods of protection which have applied in the past.

Whether the use of road traffic lights should be extended to give warning of the approach of trains at public road level crossings over the railway or not is mainly a question of more expeditious and econo-

mical working of the crossings from the Railways' point of view.

Where today a crossing is protected by gates or barriers operated by a crossing keeper or signalman with appropriate railway signals interlocked with the gates or barriers, and with road warning signs intimating the approach to a level crossing, there seems little benefit will accrue by the provision of « traffic lights » in addition, except in special cases. It must be remembered that a positive stop signal is provided by a red target on the gates when across the roadway, supplemented by a red light at night on the gates or barriers.

At crossings without gates or barriers the control of road traffic by « traffic lights » is an improvement but does not give full protection and has not been adopted on British Railways where Ministry of Transport requirements ensure that gates completely closing the roadway shall be provided at public road level crossings except in the case of certain Light Railways as referred to later. In other countries the provision of road « traffic lights » is only applied in busy urban areas and they have not been considered in rural districts where their provision would be difficult owing to the lack of electric power and the problems of maintenance in sparsely populated areas.

To sum up under this general heading, therefore, we would say that the method of protection with the lowest accident quotient is that where gates or barriers are used to completely close the roadway, operated from signal box or crossing keeper's cabin. In certain isolated cases the provision of « traffic lights » in conjunction with gates or barriers is an advantage but the installation of traffic lights in lieu of gates or barriers, with or without audible warnings, is not regarded as an adequate method of protection.

Under this heading, also, our investigations shew that there is no formula in use for ascertaining the braking distances of different types of road vehicles in connection with level crossings. The sighting distance of level crossing gates or barriers by road users is taken into consideration and if this is not adequate some form of advanced warning sign is provided to ensure drivers of road vehicles being able to stop before reaching the gates or barriers.

(g) *Methods of protection in use and proposed, and experience gained for each type.*

Here again we must report that since the 1933 Cairo Session there has been little development in the types of protection given at public road level crossings. Each country appears to have perpetuated the type of protection which was prevalent at that time. The introduction of « traffic lights » (usually associated with road junctions) for the control of road traffic over a railway crossing, with or without gates or barriers, has been very limited. We give below a consensus of opinion on developments which might be made, the nature of which is prompted by the questionnaire: —

(h) *Automatic signalling and closing of level crossing gates without keepers, worked by the occupation of the track by trains.*

In the countries whose methods of level crossing protection we have been asked to review there has been no development on the lines suggested in this heading. In Great Britain, for example, dispensing with the crossing keeper would entail automatic operation of the gates, the cost of which could not be faced.

In the U. S. A., however, considerable use is made of automatic gates or barriers and we consider it is helpful to include herein extract from a Committee Report on Highways to the American Railway Engineering Association, dated November 1949, as follows : —

The final conclusions were stated in the form of « Accident Quotients » which shew the average number of accidents per crossing per year at comparable crossings protected by the several types of protection.

(Table 1 is a summary of these accident quotients.)

TABLE 1. — *Accident quotients for several types of protection.*

Type of protection.	Accident quotient.
Automatic gates : multiple track. . .	0.0925
Manual gates : 24 hours	0.1513
Flashing lights : single track	0.1773
Wigwag	0.2936
Flashing lights : multiple track . . .	0.3044
Manual gates : part time	0.3520
Watchmen	0.3581
Automatic bells	0.3941
Reflector signs : AREA Standard . .	0.4450
Painted crossbuck signs	0.5038
Reflector signs : Michigan standard .	0.8156

It will be noted that automatic gates, having the smallest accident quotient, proved to be the most effective form of protection, followed by other types which give warning of the approach of a train, and that those types of protection, such as painted or reflectorized signs, which merely indicate the location of the railroad, are relatively less effective. It is interesting to note the relative ineffectiveness of watchmen and automatic bells in comparison with automatic gates and flashing light signals, which are currently recommended by the American Railway Engineering Association.

The superiority of automatic gates over other forms of protection shown in the above extract must of course be related to American standards and conditions. The automatic « gates » referred to are necessarily of light construction and are usually of the falling barrier type, which are much less conspicuous, and physically are negligible as a bar to road traffic as compared with the solidly constructed gates used on British Railways, for example. We are of the opinion that the standard protection for public road level crossings adopted in the British Isles would in similar conditions give the lowest « accident quotient ».

However, automatic gates or barriers are undoubtedly a means for the economical protection of level crossings where conditions do not warrant the installation of the robustly constructed manually operated swing gates and interlocked signals, and we are indebted to Lieut. Colonel G. R. S. Wilson, Chief Inspecting Officer of Railways, Ministry of Transport, Great Britain, for the following description of automatic gates on a double track suburban line of the Long Island Railroad, New York, which he inspected on a visit to the U. S. A. in 1949.

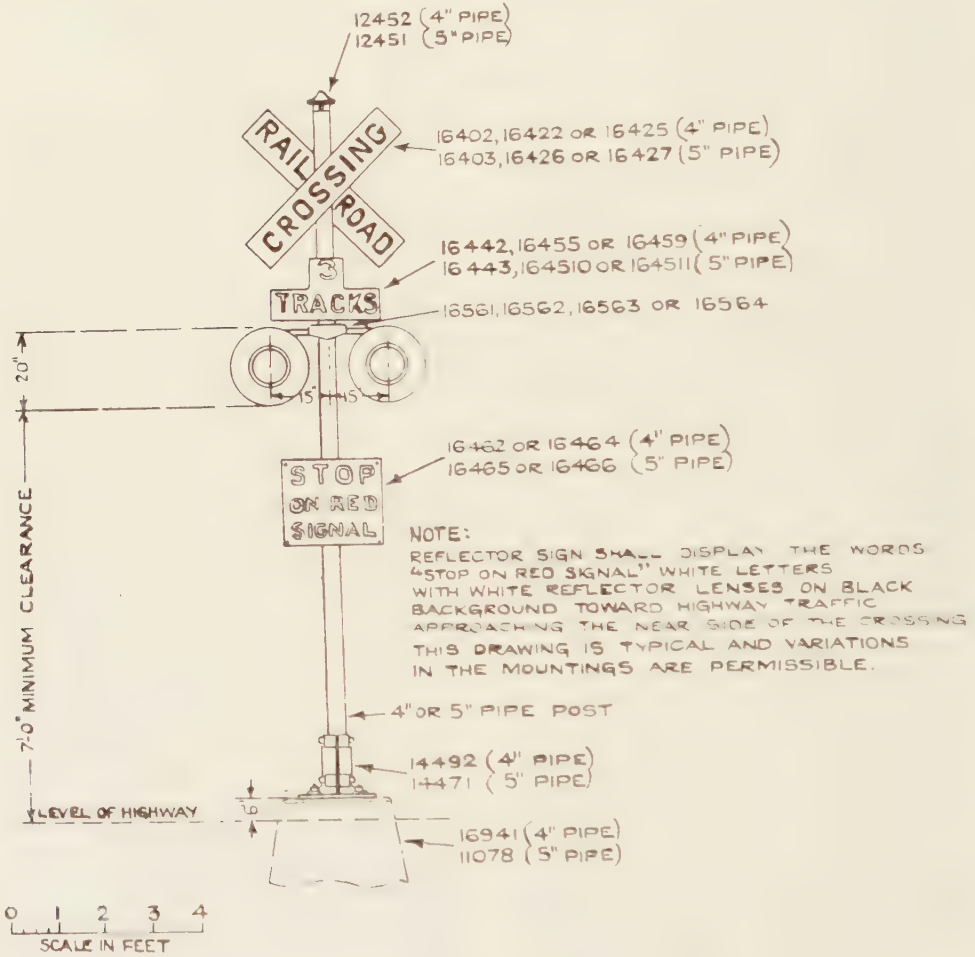
« We inspected three examples on a double track suburban line of the Long Island Railroad, carrying a service of about 45 multiple-unit electric trains in each direction during the 24 hours. They were in a good class residential district about 20 miles from New York and the roads, which were about 25 ft. wide, were fairly busy; 5 or 6 cars would be waiting during each period of closure lasting about one minute. The track circuits and controls are so arranged that the cycle begins 35-40 seconds before the fastest train reaches the crossing. Track circuit timing devices, both for automatic gates and for ordinary flashing lights or wigwags, so as to give the same length of warning for fast and slow trains are also used. »

« A standard pair of alternately flashing red lights (see fig. 1) work in conjunction with the automatic gates. The lights are lit and begin to flash, and the bell begins to sound directly the train strikes the track circuit. The bell stops after 3-5 seconds when the gates begin to fall, reaching the horizontal position in about 10 seconds. They begin to rise again directly the train has cleared the crossing, and the red lights continue flashing until the gates are again vertical, when they are extinguished. »

« The gates were of the « short arm » type, falling halfway across the road on the right hand side; there was a white line in the centre of the roadway, but small traffic islands on either side of the crossing are preferred as giving a more positive division between opposing traffic streams. The arms, which are lightly constructed of

planks and striped black and white (see fig. 2) are motor worked up and down; they are perfectly counterbalanced and can easily be lifted by one hand. Each has three red lights facing road traffic, which are lit as soon as the arm begins to descend: the end light is « fixed » and the other two are flashing. At one crossing there were miniature falling barriers across the pavement which were not much more than a gesture, and at another a side road was provided with a flashing yellow light and a stencil « No Left Turn », working in conjunction with the gates. »

« D. C. power at 110 V for the gate motors was furnished by a secondary bat-

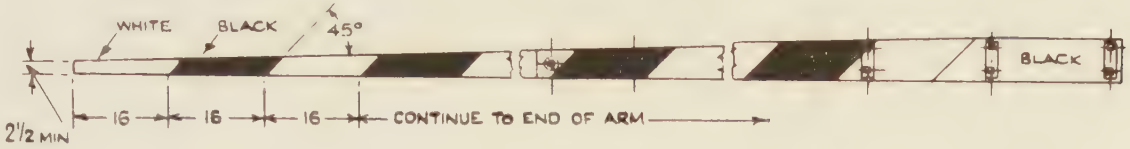

12452 (4" PIPE)
12451 (5" PIPE)
RAIL ROAD CROSSING
16402, 16422 OR 16425 (4" PIPE)
16403, 16426 OR 16427 (5" PIPE)
16442, 16455 OR 16459 (4" PIPE)
16443, 164510 OR 164511 (5" PIPE)
3 TRACKS
16561, 16562, 16563 OR 16564
20"
15"
15"
16462 OR 16464 (4" PIPE)
16465 OR 16466 (5" PIPE)
STOP ON RED SIGNAL
NOTE:
REFLECTOR SIGN SHALL DISPLAY THE WORDS "STOP ON RED SIGNAL" WHITE LETTERS WITH WHITE REFLECTOR LENSES ON BLACK BACKGROUND TOWARD HIGHWAY TRAFFIC APPROACHING THE NEAR SIDE OF THE CROSSING
THIS DRAWING IS TYPICAL AND VARIATIONS IN THE MOUNTINGS ARE PERMISSIBLE.
7'-0" MINIMUM CLEARANCE
4" OR 5" PIPE POST
14492 (4" PIPE)
14471 (5" PIPE)
LEVEL OF HIGHWAY
16941 (4" PIPE)
11078 (5" PIPE)
0 1 2 3 4
SCALE IN FEET

HIGHWAY CROSSING SIGNAL ASSEMBLY
FLASHING LIGHT TYPE.

Fig. 1.

14911 SINGLE BEARING CROSSING GATE ARM. MINIMUM LENGTH 18 FT
SPECIFY LENGTH

14912 DOUBLE BEARING CROSSING GATE ARM. MAXIMUM LENGTH 38 FT
SPECIFY LENGTH
CROSS BRACING SHALL BE PROVIDED FOR LENGTHS FROM 24 TO 38 FT.



NOTE: LUMBER SHALL BE 1IN GRADE "C" SELECT WHITE PINE OR EQUIVALENT
DRESSED FOUR SIDES
ALL LUMBER SHALL BE PAINTED ONE PRIMING COAT OF WHITE LEAD
AND LINSEED OIL BEFORE ASSEMBLY
BOTH SIDES OF GATE ARM TO BE PAINTED AS SHOWN, WITH STRIPES
SLOPING DOWNWARD TOWARD CENTER OF HIGHWAY.
LENGTH OF ARM IS MEASURED FROM CENTER LINE OF MAST TO TIP

SCALE AND ALL DIMENSIONS GIVEN IN INCHES

CROSSING GATE ARM.

Fig. 2.

tery, trickle charged through a transformer and metal rectifier from the 2 200 V overhead power signal line. There were 14 D. C. relays, and 6 A. C. track relays in the cabinet alongside. A cut out is provided which can be operated by the trainmen with a standard « switch key », so as to release the gates if, for instance, a train breaks down on the track circuit, but the signal engineer considered that the power of effecting such a release should be in the hands of the signal lineman only. »

« We understood that the Long Island R. R. are well satisfied with their experience so far, and more installations are contemplated. Records show that nearly 90 000 cycles have been completed in two years without a danger side failure and no safety side failure was recorded in ten months. »

(i) *Level crossings without keepers with automatic signals for road traffic.*

In several countries there is a measure of automatic working at level crossings but this does not include gates or barriers. Automatic red flashlight signals, track circuit operated, are provided wherever this is considered necessary, taking into account density of road and rail traffic and visibility of approaching trains. As examples we quote the following : —

South African Railways.

The number of automatic flashlight signal installations in use is 116 and the number contemplated for installation is 6.

Automatic gates or barriers are not used and trials made with them some years ago were not considered satisfactory.

The recognised flashlight installation consists of two red flashing light signals units placed under each « Close Up » warning sign, at a height of approximately 7′ 0″ above the ground and situated about 10′ from the railway lines.

Signal units each have a mirror (Silvered glass not metal plated), a normal 8″, 30° spreadlight lens and two clear glass side windows, one either side of each lamp unit, to give an indication to drivers of trains that the signals are operating.

The lamps used have been 9 V 15.3 W prefocussed, single centre contacts but will be replaced ultimately by 12 V 12 W lamps S. L. 16.

Flasher relays used are the G. R. S. type K, D. C. 600 ohm for 10-12 volt operation.

Warning is given by normal track circuit operation, either A. C. or D. C. fed, depending on whether the line is electrified or not. A minimum warning of 25 seconds is given for the fastest train.

Power supply to lamps and flasher relay is obtained where possible from a trickle charged secondary battery. If a source of A. C. power is not available primary cells of the caustic soda type are used.

Where necessary or feasible, the operation of the lamps is repeated in the nearest attended signal cabin by the use of 1 4 ohm series relay.

Circuit diagrams for double line and single line are given (see figs. 3 and 4).

The lamps of each pair of light units light alternately at a rate of approximately 30 flashes per minute.

It is not the policy to use audible signals as a general rule. Trembler bells are occasionally used for the warning of pedestrians, whilst the flashing light signals are relied upon to warn road traffic.

It is not considered necessary to give road traffic a « line clear » indication when there is no train in the warning area.

It is a matter of opinion whether automatic signals without bars or gates are a satisfactory solution in the case of a double track railway. There exists the possibility that a road user may, after a train has passed, neglect to observe that the signals are working for a train approaching on the other line.

The onus of crossing any railway level crossing is placed on the road users. No telephones to signal cabins are provided.

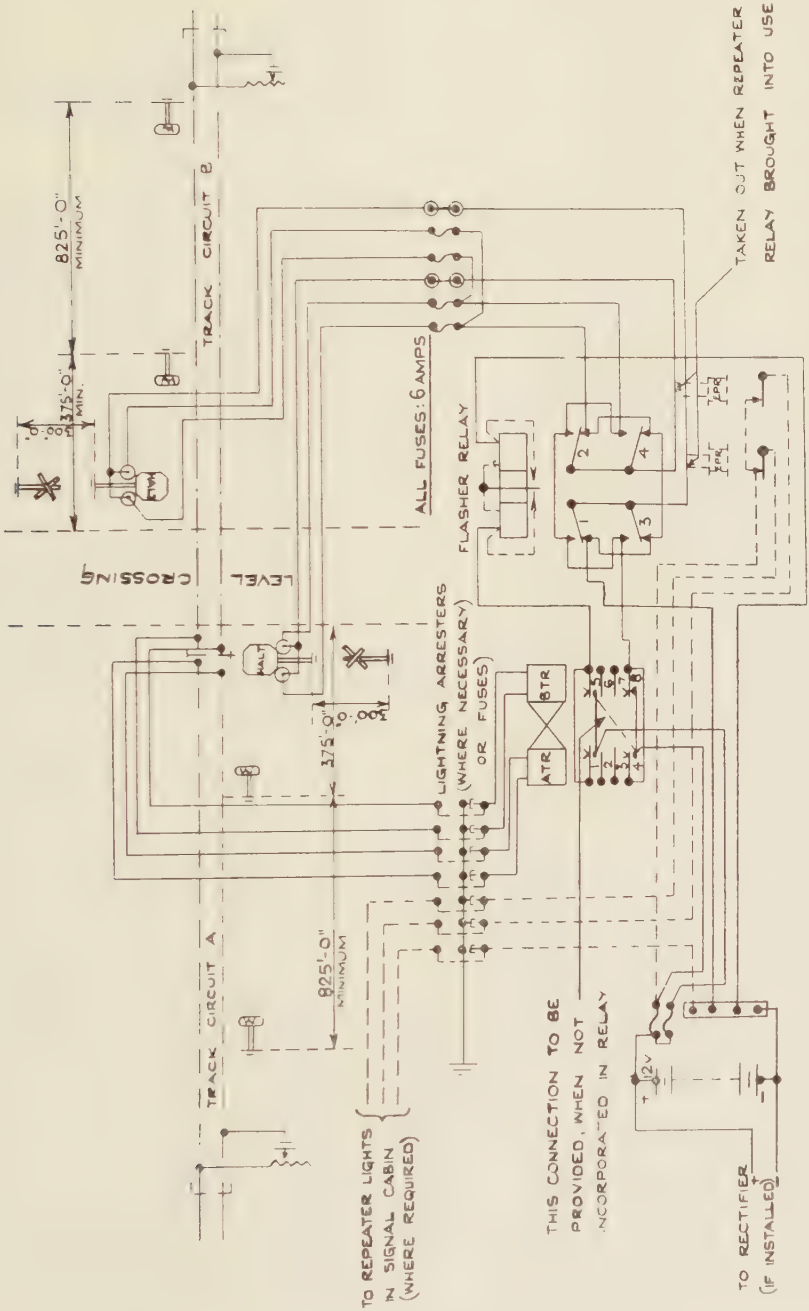


Fig. 3.

S. A. R. S. A. S. Level crossing. Single line. Non electrified.
Type wiring diagram for flashlight signals with double rail D. C. track circuits.

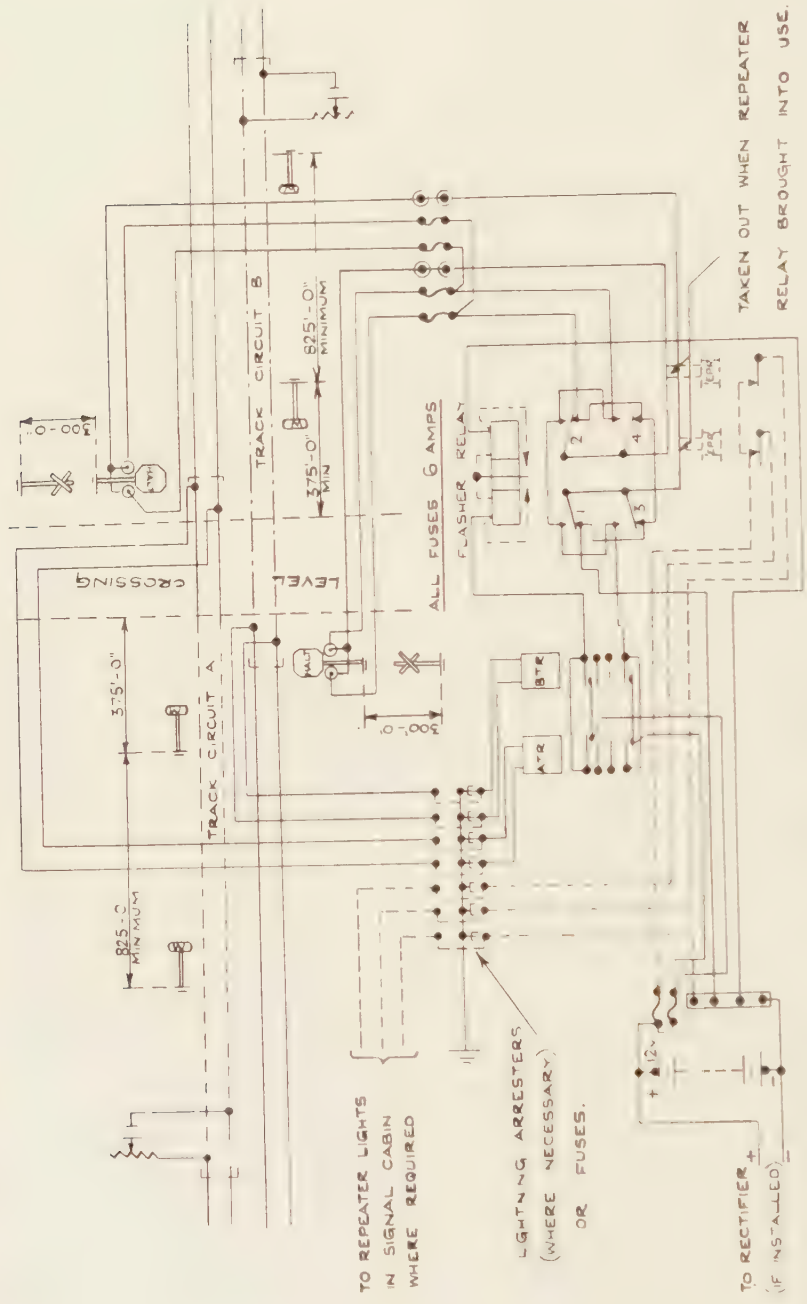


Fig. 4.

S. A. R. S. A. S. Level crossing. Single line. Non electrified.

Type wiring diagram for flashlight signals with double rail D. C. track circuits.

As automatic gates are not used, if the automatic flashlights operate continually, it is expected that the road user, after stopping, will proceed over the level crossing after ascertaining from visual observation that it is safe to do so.

Rhodesian Railways.

Although a number of factors have to be taken into account when deciding the necessity for the provision of automatic flashlight signals in these territories the major consideration is the density of road traffic. So far these lights have only been provided in urban areas where they can be readily maintained.

Fifteen crossings in Northern and Southern Rhodesia are fitted with flashing light signals but no gates or barriers are provided. There is no extension of this number contemplated at the moment.

The installation of flashlight signals consists of two pairs of signal lights on either side of the level crossing; the lights flash alternately and throw a beam of 40°. On the railway side whistle boards are fixed on the left hand side of the track about 1 1/4 mile on either side of the level crossings.

The method of control is by interlocking track relay which when de-energised causes the flasher relay to come into operation, giving a flashing rate of approximately 40 flashes per minute. The whole installation, including the operation of the flasher and flashlight relay and the lighting of the signals, is fed by one set of 12 V secondary cells trickle charged by means of a copper oxidised rectifier, while the track circuits are fed by two Edison primary cells per track circuit. These track circuits are so situated as to give about 20 seconds warning to road traffic.

A red flashing light only is provided and it is not considered necessary to amplify the visual signals by sound signals.

The flashing light signal is a warning to road traffic and it is not considered necessary to provide a « line clear » indication to road traffic.

In the case of double track, standard warning boards only are used as automatic signals without bars or gates are not considered satisfactory in such cases.

Protection signals at level crossings are warning signals and are not definite stop signals. Should an automatic stop signal become out of order and flash continuously it is the responsibility of the road user to determine by observation whether it is safe for him to cross the railway track.

Egyptian State Railways.

Sometimes it is the volume of road traffic only which governs the decision when considering automatic signalling but in the majority of cases it is the traffic factor (road and rail) which is taken into account. So far the system has been used only in or near big cities where electric supply and specialised labour are available.

Twelve automatic road signalling installations are in service and 10 more are contemplated.

Diagrams of the arrangements are given (see figs. 5 and 6).

Only one aspect red flashing colour light signals are used. There are no gates or barriers.

Bells are used to duplicate the visual signals.

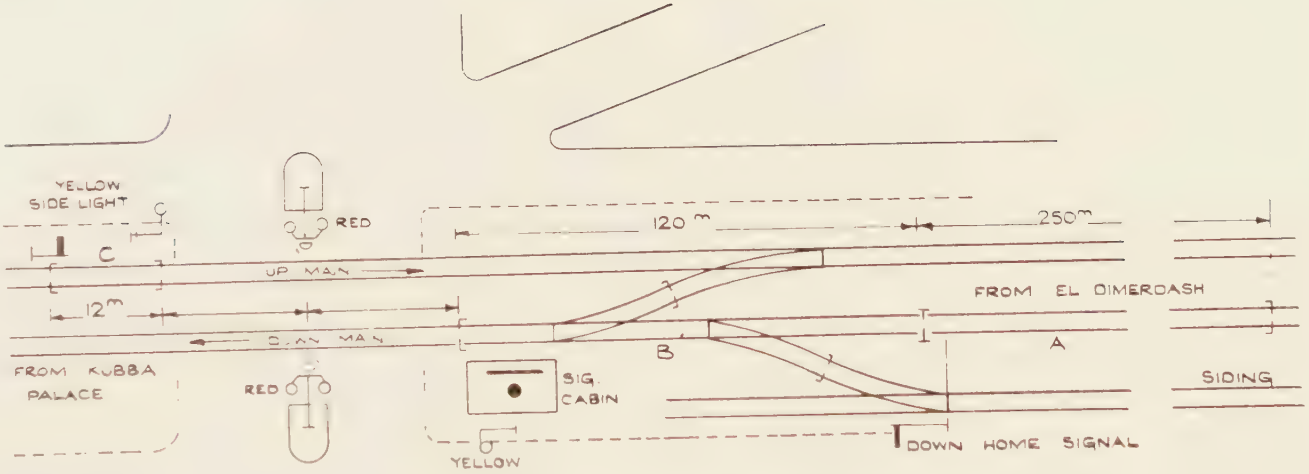
A « line clear » indication is not given and is not considered necessary when no train is approaching. This saves current.

A minimum warning of 50 seconds of an approaching train is given to road traffic.

The lights are usually supplemented by a traffic policeman, who notifies the electrician in charge of maintenance if there is a failure of the lights and bells.

(j) *Level crossings with gates and keepers.*

A general description of the systems in use on the various railways was given by Mr. Newlands is his Cairo paper and we do not propose to repeat this, but to amplify the information given to cover the



KOBBRI EL KUBBA L. XING

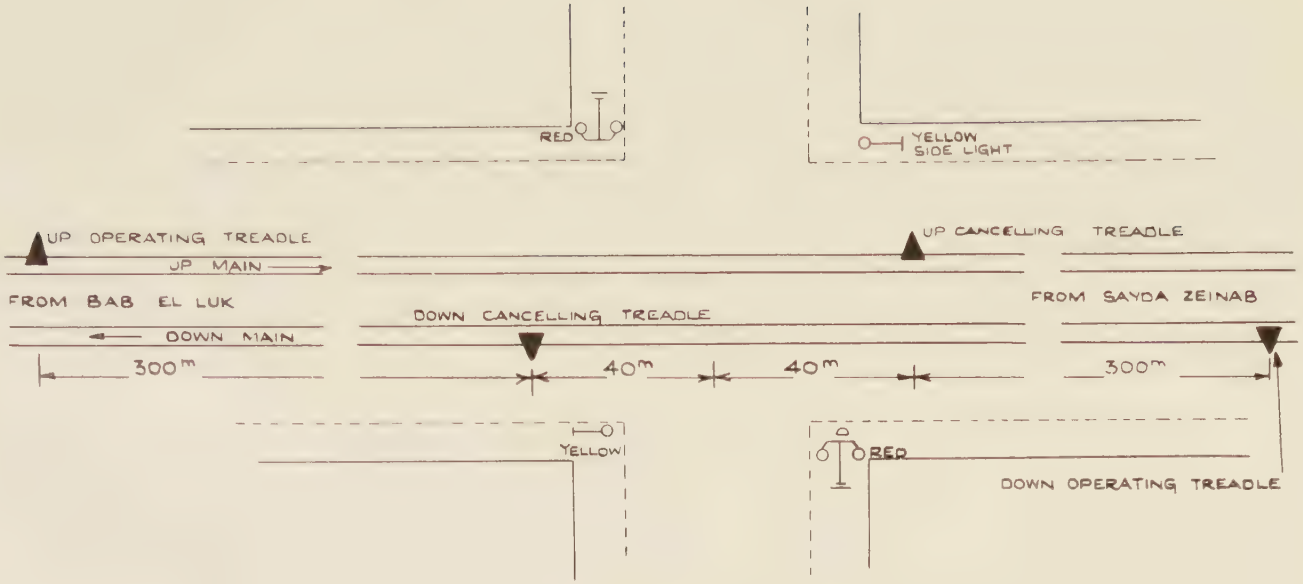
Fig. 5 — *Egyptian State Railways*

Kobbri El Kubba L. Xing.

A. L. X. control lever when normal causes L. X. lights and bells to operate. No cancelling is possible until it is returned to the reverse position. Up starting and down home signals are locked by the L. X. control lever.

B. *Down line.*
L. X. lights and bells operate when :
1. Track B is occupied. No cancelling is possible;
2. Track A is occupied. Cancelling could be done by pressing the cancelling key (track B must be clear).

C. *Up line.*
L. X. lights and bells operate when C is occupied.



TORQA EL SHARQI L. XING

Fig. 6. *Egyptian State Railways.*

Torqa El Sharqi L. Xing.

When the train passes over the operating treadle (on either up and down line) the L. X. bells and lights operate and remain operating until the train passes over the cancelling treadle.

points raised in the questionnaire now being reported upon.

British Railways.

The normal practice is to give warning to the crossing keeper by indicator and/or bell working in circuit with the block signalling apparatus. The time length of the warning varies. Location of the crossing as related to the block post in rear, density and nature of traffic, approach view and all other relevant factors are taken into consideration.

Manual warning as described is considered sufficient. It can readily be made flexible to meet varying conditions.

Automatic warning, although eliminating possibility of failure of the human element, is not justified in cost except in automatic signalled territory where block posts are widely spaced and/or block apparatus is not in use.

No formula has been determined as to the length of time above which the warning becomes useless, each case being considered on its merits, and apropriate instructions are issued to the crossing keeper as to when he is to close the crossing to road traffic after « Line clear » or « Train entering section » has been given on the block instruments. In special cases a treadle or track circuit operated enunciator is provided.

In the case of automatic warnings the time factor is governed by local conditions but with all circumstances favourable 90 seconds would be considered a minimum.

The practice of giving a preliminary warning or « alert » is not adopted and apart from a minimum length of warning being given no account is taken of the varying speed of trains.

Since the gate keeper is aware of the passing of a train automatic cancellation of warning is only advantageous in a few instances e. g. where the warning is by repeater block indicator and a train remains in a section for a considerable time after passing the crossing, or where warning is by prolonged ringing of a bell which could be prematurely cancelled by the crossing keeper.

As previously stated, automatic warnings are seldom used but in the case of a double track the warning is indicated separately for each line.

The number of automatic train signalling devices installed at level crossings during the last five years is nil.

It will be appropriate to quote here the Ministry of Transport requirements for public road level crossings :

« *Public Road Crossings.* — At all level crossings of public roads, gates, where prescribed, must be constructed to swing alternately across the railway and across the road on each side of the crossing. They must be hung so as to be incapable of opening outwards towards the road. Stops to be provided to keep them in either position. »

« Where the normal position of gates is across the roadway, arrangements will be required to work them either from a signal box, or by an attendant, for whom special accommodation may be necessary. Similar arrangements will be required where the Minister has issued a direction that the normal position of gates is to be across the railway, unless such gates are to be worked by the trainmen. The standard gated level crossing warning signs on the road approaches are the responsibility of the Highway Authority. »

« At public road level crossings in or near populous places, gates to be either close-barred or covered with wire netting. »

« Gates to be painted white and to carry red targets and red lamps, one on each side of the crossing. Targets and lamps to shew in both directions along the road or railway according to the position of the gates : they need not however shew towards the railway if there is a stop signal protecting the crossing. « Cat's eye » reflectors to be provided where necessary at crossings over important roads. »

« Worked distant signals, interlocked with

the gates, to be provided, unless traffic conditions, view of gates, etc., warrant the omission of this additional protection. The use of unworked distant signals to be restricted to level crossings where the gates are normally closed across the railway and are operated by the trainmen, but for such crossings suitable distant warning notices, illuminated at night if necessary, are preferable. »

« At important level crossings, or where conditions require them, stop as well as distant signals interlocked with the gates to be provided. »

« At level crossings of public roads or footpaths a bridge or a subway for pedestrians may be required. On wicket gates, bolts may be necessary to enable the signalman or attendant to lock them. »

« Attendants at level crossings should, as a rule, receive warning by indicator, bell, or both, of the approach of trains from either direction; a telephone may also be necessary, depending on local conditions. »

« At crossings carrying heavy road traffic, warning that the gates are about to be closed across the road may, in approved cases, be given by traffic light signals of standard pattern, interlocked with the gates. »

Rhodesian Railways.

There are no manned gates or barriers in these territories nor are any public level crossings provided with gates or barriers.

Egyptian State Railways.

On main lines and also at important level crossings on branch lines where visibility is bad owing to curves, trees, etc. it is the practice to install bells for warning the crossing keeper.

Manual warning is preferred with an acknowledgement bell code or telephone.

A warning longer than 10 minutes is regarded as ineffective but it depends on the distance from the block post from which the warning is given.

There is no system of automatic warning in use and no arrangement of giving an « alert » prior to the warning is in use or considered necessary.

No consideration has been given to the adoption of a constant length of warning for all classes of trains and it is not thought that this is necessary.

The painting of gates or barriers has been changed to red and white instead of the usual black and white. Red lights on the gates or barriers have always been used and experiment is now being made with a material called « Scotch light », which is stuck to the gates or barriers and shines very brightly when the headlights of cars are directed to the gates or barriers.

Traffic lights are used in lieu of gates or barriers but not in amplification of gates or barriers. Distant control of gates or barriers is not in use, neither are flexible gates or barriers.

South African Railways.

As long a warning as possible is given to the person in charge of a crossing but this is usually adjusted as the result of experience. Too long a warning results in delays to road traffic, whilst too short a warning results in delays to trains.

If a gate controlled crossing comes, within the area of an interlocked station, warning is given by the signalman in charge by bell signal, otherwise warnings are given by means of track circuits.

Above 8 minutes, it is considered a warning might be useless unless the gate keeper is intelligent and efficient.

In the case of an automatic warning the minimum time which will elapse before the train reaches the crossing is 40 seconds but this is increased according to the road traffic density. It is not considered necessary to give a preliminary warning or alert before the final warning of the approach of a train, neither has it been found necessary to arrange for the length of warning time to remain constant whatever the speed may be — the minimum warning time is fixed to cover the fastest train.

It is found advantageous to cancel a warning automatically in the case of multiple tracks only.

In the case of two or more tracks gate keepers are given warning indications for each track separately.

In the last five years only one set of barriers and warning devices has been installed. The policy in South Africa is to eliminate barrier controlled crossings by the provision of bridges or subways.

Each barrier carries a red disc and light. Flashing light signals are also provided to give adequate warning. This was found necessary at least 20 years ago to prevent damage to barriers. Road traffic lights are seldom provided in lieu of gates or barriers where crossing keepers are employed.

When a level crossing is used largely by pedestrians, wicket gates without interlocking are provided in addition to road barriers. These wicket gates are closed at the last moment possible. The problem of trapped pedestrians is not peculiar to level crossing barriers worked from a distance, which is avoided where possible, but at some level crossings a turnstile type wicket gate is used with a ratchet feature which allows egress from but not admittance to the level crossing.

Swing gates are not used at public level crossings. Rigid booms are used, either tubular or lattice, with flexible or semi-flexible fringes. The flexible type consists of a network of solid wire pieces about 6" long, hooked at either end to light metal rings. The semi-flexible type consists of vertical metal slats about 1" wide and 3/16ths" thick, which depend from the boom. Both are effective and easily repaired.

Indian Government Railways.

At non-interlocked level crossings the gate keeper depends on the range of vision or audible warning or whistle of the approach of trains, and is governed by rules laid down that the gates will normally remain closed to road traffic. Where the road traffic is heavy and visibility is impaired, due to curves and other factors, signals interlocked with the gates are provided. At busy level crossings a telephone is also provided at the level crossing, connected to the nearest block station.

As an alternative to manual warning by bell or telephone, warning by track circuits or treadles is used. The particular method adopted depends on local conditions.

As regards the length of the warning, this depends on the speed of trains, the location of the level crossing and the type and number of gates used. Where a telephone communication is provided the warning is usually given immediately after the train enters the block section in which the level crossing is located. The minimum time required is 3 minutes but where the warning is by automatic means a minimum of 2 minutes is usually allowed.

The amplification of the warning by an alert is not in use in India.

In the case of double track, as gates have to be closed in every case, no differentiation is made for trains from different directions, except where the warning is by telephone, when the direction of the train is given to the gate keeper.

The number of automatic train warning devices installed during the last five years is very small. On the E. I. Railway only one such device has been installed, which is briefly described as follows :

The level crossing is situated across quadruple tracks about a mile and a half from the signal cabin of one station and about two miles from the signal cabin at the station on the other side of the crossing. The road and rail traffic are both fairly heavy. To ensure speedy operation the level crossing is protected by lifting barriers instead of hinged gates. Signals interlocked with the barriers have been provided for rail traffic on both sides of the crossing. A warning bell worked by track circuits has been installed at the level crossing. The arrangement has proved very satisfactory.

The only progress that has been made to make the crossing gates or barriers more visible to road users is the provision of red cluster reflecting signs at places where lamps did not previously exist. Road traffic lights are not used in conjunction with crossing gates or barriers.

Turnstiles ares provided alongside the road gates for use by pedestrians.

No flexible gates are in use in Indian Government Administration.

New Zealand.

There are very few crossings protected by gates with keepers in New Zealand.

The method of giving warning of the approach of trains is automatic by track circuits, except for shunting movements. The length of the warning is 15 seconds on single lines and 20 seconds on double lines. An alert to precede the warning is not used.

It is considered essential to have the warning automatically cancelled by the train itself after passing the level crossing in order to avoid delays to road traffic.

Twenty four automatic train warning devices have been installed during the last five years.

In the few cases where barriers are used, those only extend halfway across the road so there is no question of road users being trapped.

(k) *Level crossings without keepers and without automatic devices giving warning of approach of a train.*

British Railways.

Ungated public level crossings are only permitted on « Light » Railways i. e. lines of low category where rail traffic is infrequent and speeds are low. Warning signs are provided in accordance with Ministry of Transport requirements.

Drivers must sound the engine whistle when approaching ungated public level crossings. The ordinary engine whistle sounded for a few seconds is considered adequate. No improvement to the usual engine headlamps at night has been found to be necessary.

Cattle guards are provided on each side of the crossing over the railway in such a way as to prevent animals straying along the railway, without impeding the passage of animals over the railway.

There is a small number of crossings on minor branch lines without keepers but where gates are provided, which are normally open to road traffic. The gates are operated for the passage of trains by the train crew.

Rhodesian Railways.

Railway Regulations lay down that a driver must give one long whistle when the engine or leading vehicle reaches the level crossing warning board (situated at the side of the railway track about 1/4 mile from the level crossing). At second whistle must be sounded 50 yards before the train reaches the level crossing and this must be continued until the engine is actually on the public road. The engine whistles in use are powerful and found to be satisfactory.

The type of engine head light employed is Stones Steam Turbine Electric Headlight which gives a beam of 110 ft. candles intensity at 75 ft. (32 V 250 W). These large head lights have proved satisfactory and it is not considered any useful purpose would be served by dipping or flashing.

Egyptian State Railways.

The engine whistle is used when approaching a level crossing only where visibility is poor. The ordinary engine whistle and head light are found to be satisfactory.

South African Railways.

Drivers are required to give two whistle signals, viz :

(*a*) A short blast at a whistle board 400 yards from the crossing and lasting for 100 yards;

(*b*) A long blast from a whistle board

125 yards from the crossing and until the engine passes over the level crossing.

No improvement beyond the ordinary engine whistle and head light have been found to be necessary.

Indian Government Railways.

There are no level crossings as described in this heading on Indian Government Railways.

New Zealand Railways.

Whistle signal from the locomotive has to be given at all public level crossings.

The duration of the whistle and the point of sounding are left to the discretion of the engine driver.

The ordinary engine whistle and engine head lights are found to be satisfactory.

II. Private level crossings.

As already stated in the Introduction, the definition of a private level crossing is that there is a restricted user of such crossings limited to the owner of the land on each side of the railway, or, where access to property from a public road is severed by the railway, tradesmen and others who have legitimate business with the owner of the property can make use of the level crossing. On British Railways, the terms used to describe the crossings are « accommodation crossing » in the circumstances first described, and « occupation crossing » in the last instance.

The problems involved in the use of private level crossings do not appear to be so acute in other countries as in Great Britain where the density of rail and road traffic is so high but as no doubt similar difficulties are encountered in all countries to some extent we are dealing fairly extensively with the position in that country.

British Railways.

The legal position at private level crossings in Great Britain is that the Transport Commission, as successors to the various Railway Companies, are responsible only for the maintenance of the fencing and gates and the roadway over the railway between the gates. They are not under obligation to otherwise protect the users of the crossing and cannot be held responsible for injury to persons or animals, or damage to property being taken across the railway, except in special circumstances.

Protection, with some exceptions, is confined to field gates opened by the road users, and in some cases cattle guards are installed, but safety of rail traffic as well as their own depends on the care and vigilance of the road users. The large majority of such crossings in Great Britain are still of agricultural field to field and farm to road type and are used mainly by persons acquainted with local conditions, but the risk of serious derailment is no longer negligible with the increasing use of motor vehicles, including heavy lorries, tractors, elevators, combined harvesters and other types of modern farm equipment.

The main risk of accident occurs at those occupation crossings which in the course of years have acquired a much heavier user and in many cases have assumed the character but not the legal status of public road crossings.

The gates provided are usually of the single field type which close against the road but not against the railway. They are hung to open away from the railway so as to close when released after opening. They are provided with self closing latches and are intended to be fastened when not in use. There are penalty notices fastened to the gates « Keep this gate shut. Penalty 40/— ».

In the majority of cases there is not room inside a gate for a vehicle to stand clear of the railway and the practice should be to open the further gate first so as to have a clear run over the railway and through the gate on the other side, after which the user should return to close the gates. This practice should also be followed where there is only one man in charge of cattle. Unfortunately, where a crossing is in fre-

quent use there is a tendency to prop the gates open with the consequence that animals stray on the line and frequent accidents occur due to this.

Whistle boards are sometimes provided at an appropriate distance on each side of a level crossing when the sight of approaching trains from the crossing is restricted from various causes, but it is not the general practice to provide whistle boards.

At some crossings where droves of animals, heavy vehicles, tractors, etc. are frequently being taken across the railway a telephone is provided at the crossing, connected to the nearest block post, so that it can be ascertained when it is safe to cross. The apparatus is usually provided at the cost of the owners of the crossing, who also bear maintenance costs.

Modern developments in agriculture are bringing many problems to be faced so far as crossings over the railway are concerned. For instance, farmers are finding great difficulty in getting their vehicles and implements across the track. The regulation gates between the fields and the railway are 10′ wide and it is impossible to get large trailers and combines through them. The railways will only widen the gates if the full cost is paid by the owner.

The users of private railway crossings are advised and constantly reminded that they are under obligation to tell the nearest station master when they require to take exceptional loads, heavy vehicles, etc. across the railway so that handsignalmen can be posted to protect the operation, but the nature of the traffic now using such crossings has altered by the growth in the employment of modern farm equipment to an extent where it is virtually impracticable to carry out this requirement to the full extent. Where handsignalmen are provided in connection with legitimate user the cost is borne by the railway Executive.

There are more than 22 600 accommodation and occupation crossings in Great Britain and it has been stated that over 700 carry road traffic greatly differing in volume and character from that for which they were originally provided, also that over 200 of these have become in substance, though not legally, public crossings. This growth in the user of many private crossings is due to a variety of causes such as the development of land only accessible by an occupation crossing for industrial purposes, caravan and camping sites, factories and aerodromes, etc.

There is infinite variety in the conditions applying to the many private level crossings in Great Britain. An interesting example exists at an Aerodrome near Bristol where the hangars erected for the housing and servicing of the « Brabazon » and other large aircraft are situated on the down side of a double railway track, whilst the airfield and runways are situated on the up side of the railway. The aircraft are towed by tractors between the hangars and the airfield over the crossing, which consists of a 90′ wide concrete roadway between the railway fences. The crossing is closed by 90′ electrically controlled sliding gates operated from a switch room adjacent to the crossing. The controlling switches are operated by an employee of the Aircraft Company and are released by a lever in the nearby railway signal box. The method of operation is for the gate keeper to telephone to the Air Traffic Controller on the airfield, who in turn telephones to the railway signalman asking for permission to use the crossing. The railway signalman, if in a position to release the crossing, informs the Traffic Controller of the length of time available for the crossing to be used and he then operates the release lever in the signal box which enables the gate keeper to operate the gates. The operation of the release lever in the signal box locks the appropriate railway stop signals for both directions at danger, also the release lever in the signal box cannot be operated unless certain track circuits are unoccupied. The release lever cannot be returned to normal to enable railway traffic to be resumed until the crossing gates

have been properly closed and locked across the level crossing.

There are a number of ways in which a greater measure of protection can be given at busy private crossings e.g. by bridging, by diverting the roadway to a nearby existing bridge or public level crossing, by dedicating the roadway to the public and providing the standard public crossing form of protection, or by maintaining the private status of the crossing and providing some form of warning apparatus with or without controlled barriers or gates.

As matters stand at present, protection at the great majority of these private crossings is confined to field gates opened by the road users, and, as has been mentioned, safety on rail and road depends primarily on their care and vigilance. The law still lays down no specific obligation on any of the parties concerned to provide and pay for the added protection which the increased risks demand but, usually, the railways have not been responsible in any way for the increase in road traffic at private crossings. The whole difficult question has been reviewed in a recent report by the British Transport Commission which is now under consideration by the Minister of Transport.

New Zealand.

Provided a private level crossing has been authorised for vehicular traffic, no obligation is placed upon the users to advise the railways where heavy vehicles, exceptional loads, etc., are to be taken across the railway.

It is not the practice to provide telephones at such crossings to enable the users to ascertain when it is safe to cross the railway.

Where there is heavy local industrial traffic over a private crossing warning bells are provided.

There is one case where an airstrip crossing is provided with fixed signals both for rail and air traffic. The time delay in clearing after rail or air traffic is two minutes.

Indian Government Railways.

In the case of exceptionally heavily loaded traffic which would be likely to endanger the safety of trains, the user of the crossing has to obtain the permission of the railway authorities before crossing the track.

The provision of telephones at unattended crossings has not been introduced.

It has not been found necessary to provide warning bells at private crossings as these are mostly across unimportant tracks such as sidings to factories, etc.

There are certain level crossings which are used entirely by other Government Departments such as the Canal Department. These are unmanned level crossings with gates permanently locked and used by canal officials who have a master key with them. These level crossings are on roads along the main canals and distributaries.

South African Railways.

The onus of crossing over any railway level crossing, whether public or private, in safety is placed on the road users.

There are no special conditions applying to private level crossings.

Egyptian State Railways.

It is apparently the practice in this State to employ keepers at all level crossings, whether public or private, except where only footpaths cross the line.

Rhodesian Railways.

As previously stated, responsibility for crossing the railway in safety in those territories is placed upon the road users.

No level crossings are provided with gates or barriers except in the case of certain private field crossings, where the operation of the gates is the responsibility of the user.

III. Level crossing of railway tracks by a road carrying a running railway (urban or suburban).

The number of level crossings of this category is very few. There are none on British Railways and the correspondents in other countries report the same position, with the exception of the following : —

New Zealand.

Generally speaking no signal is given to road traffic other than a stop signal when a train is due. Road traffic is then stopped by flashing red lights, bells, etc., while the train has right of way. As soon as the train has passed and the road crossing clear, the signals stop and the road traffic has right of way.

In a few instances where trams cross the railway both tram and railway traffic is controlled by interlocked railway signals. In these cases preference is given to the rail traffic for right of way.

An instruction states — Speed must be reduced to 25 m.p.h. over these crossings when crossing keepers are on duty and to 6 m.p.h. when crossing keepers are not on duty. Trainmen must be prepared to stop their trains if necessary before fouling any of these crossings.

There is no difference in the length of warning given by automatic signals to drivers of road vehicles and to drivers of rail vehicles passing over the crossing.

Derailing switches are not provided.

South Africa.

Such a crossing is treated exactly as any other.

Distant and close-up warning signs are provided and flashing light signals function when a train is approaching the level crossing.

* * *

We would say, from the point of view of British Railways, that if any such crossing was contemplated a controlling signal box would be installed and protection for the railway would be implemented to include catch points or other derailers for the rail vehicles using the level crossing so as to protect the purely railway movements. Automatic protection on similar lines could no doubt be devised but the main consideration would be the protection of railway movements.

INTERNATIONAL RAILWAY CONGRESS ASSOCIATION

ENLARGED MEETING OF THE PERMANENT COMMISSION
(STOCKHOLM, 1952.)

QUESTION III.

Economic aspects of :

a) discontinuing service on old railway lines;

b) construction of new railway lines;

with regard to the possibility of handling transport with other means.

REPORT

(America (North and South), Australia (Commonwealth of), Burma, China, Ceylon, Denmark, Egypt, Finland, India, Irak, Iran, Irish Free State, New Zealand, Norway, Pakistan, South Africa, Sudan, Sweden, United Kingdom of Great Britain and Northern Ireland and the territories for whose international relations the United Kingdom is responsible),

by Arne SJÖBERG, M. A.,

Chief Research Economist, Swedish State Railways.

I. The general problem of adaptation of railway facilities to changing conditions.

The growth and development of the national economies of the world have been closely related to the development of transportation. The dynamic, ever-changing nature of economic life in all industrialized countries necessitates continuous adjustment of the transportation system to changes in the nature of demand for transport services; to technical improvements in different means of transport, causing shifts between these means in their relative economy and serviceability; to changes in economic organization; and finally, to changes in government transport policy.

Such adjustments of the transportation system to changing economic and technical conditions have occurred throughout the history of transportation. From the advent of railways up to about 1920, these adjustment processes in most countries mainly consisted in the endeavour to keep railway construction and development abreast of the needs of the rapidly growing population and mounting industrial production. Since 1920, the situation has radically changed and the transport problem is no longer merely a railway problem. In view of the rapid economic and technical advances made by the railways' competitors in the highway, waterway, pipeline and airway fields, the general problem of the transportation system is now more heterogeneous and complicated than before. Though still the backbone of inland freight, and in most countries of inland passenger transportation too, the railways

nowadays have to share a considerable part of the total transportation volume with these younger services. Each of these services competes with the railways on an increasing and intensified scale. In order to maintain their place in the transportation system, it is necessary for the railways to adjust their policies on size and development of railway facilities, operative methods, pricing, etc. to the changed conditions on the transportation market.

A country's transportation system is dependent on its geographical nature, the size, regional distribution, and general structure of its population and economic life, the economic and technical structure of its existing transport facilities, and the varying aims of its transportation policy at different times. Since these factors determining the character and extent of the transportation system have shown fundamental differences at different periods, they have entailed numerous and varied problems of adaptation with regard to the length and course of railway lines, their density per unit of land area, the number of stations and junctions and their location, etc. In view of the geographic rigidity that characterizes inland transport routes (railways, highways and canals) this process of adaptation, if carried through at all, has usually been exceedingly time-consuming and inadequate.

The modification of a railway system by closing down old lines or by adding new ones is an important example of the problems of adjustment encountered in adapting the transport system to those changes in transport technique or in the extent, nature, and trend of the demand for transport services that occur in a dynamic commercial and industrial system. Certain changes of this latter kind may be relatively limited with respect to time, involving only minor alterations in the structure and scope of the transport services. So far as the railways are concerned, such changes generally require adjustments only with regard to price or production policy within the framework of the existing services; hence they seldom have any repercussions on the traffic volume of such magnitude as to necessitate the closing down or construction of railway lines. However, other changes in the demand for transport services, associated with more far-reaching changes in the way of life of the community, may serve permanently to alter the nature and scope of that demand. Such major changes may lead to radical and large-scale modifications of the transport system as a whole and, where the railways are concerned, to the consideration of a change-over to entirely new forms of operation, greater expansion or greater reduction of lines and rolling stock, etc.

Railways, like other land transport facilities, are characterized by relatively great rigidity in regard to the geographic extent of existing routes. Comparatively substantial changes of long duration are therefore required in the magnitude and nature of the demand if they are to influence the railways' policy relative to the construction of new lines and other permanent establishments. The main reason for this lies, of course, in the vast outlay that every such change in the railway system involves. With regard to cuts affecting the size or operation of railways, it is usually another factor that serves to limit their adaptational capacity: namely, that the railways generally occupy such a position in the national transport system and economic life that considerations other than directly financial often fundamentally influence their scope and modes of operation. For instance, social, strategic, political, and other public interests may make such demands on a country's railways that major obstacles will arise to any rational adjustment of the capacity and organization of its transport services to the actual work they have to perform.

In most countries, the transport requirements have undergone fundamental changes with respect to nature, scope, and geographic distribution since the first days of railways. Up to the end of the second decade of this century, there proceeded a

continuous long-term increase in the traffic volume of the railways — which development largely coincided with the epoch of railway construction. During this period, the railways were the predominant means of land transportation in most countries. Because the primary need of transport facilities that once prompted the advent of railways mounted in pace with the continued geographic expansion and increasing capacity of the railways, and because the latter themselves were often, in the last analysis, responsible for the new needs that gradually arose, exceedingly good requisites existed for a continuous and effective adjustment of the transport system to the existing or anticipated requirements. The general view that the railways offered great possibilities of resolving all conceivable transport problems entailed, however, in most countries with railways, many somewhat irrational railway projects and construction schemes. In certain circumscribed regions the railway capacity, therefore, sometimes became far too great in relation to the existing demands on it. A lack of balance between demand and available facilities resulted, in many cases, from the fact that in certain respects the advent and configuration of the railway network were characterized by local and regional political interests, by speculations in personal gain, or by other motives with little or no bearing on the question of an economically sound adaptation of the size and organization of the transport system to the total need of transport facilities then and in the future. The development of railways in relation to the general economic trend during different periods is treated more exhaustively in Chapter III.

In certain countries, general state plans for the expansion of the railway system were devised from the very outset. However, State planning and control were in general limited to the question of the location and course of certain trunk lines; the network of branch lines or of local lines linked therewith being delegated in great part to private or local interests. Local pride, the romantic aspect of railways, and a desire « to be on the railway map » prompted many such branch and local lines that began and ended at unimportant places. In many cases the extent of and the area served by the trunk lines were determined by other considerations than economic, e. g. considerations of defence policy or the desire that the new lines should bring economic prosperity to previously undeveloped regions (« breakground » motive). The planning of locations and routes, and problems associated therewith, are treated in greater length in Chapter II.

Whereas the years up to 1895 constituted the era of extensive railway construction, which saw the advent of the main lines in most national railway networks, and in which the foundations of those railway systems were laid, the period from 1895 to 1920 was to emerge as the age of more intensive expansion, during which the existing main-line network was implemented and improved in various respects by the establishment of branch lines, the addition of a second or third main line to previously single tracks, and further sidings at marshalling yards, etc. The years since 1920 may be characterized as the epoch of commercial and technical rationalization of the railways. This development must be viewed with due regard to the far-reaching structural changes in economic, political, and social conditions which occurred in most countries after World War I, and which were to bring in their trail comprehensive changes in the volume and nature of transport requirements as well as in competitive conditions on the transport market. By 1920 the epoch of railway construction had more or less been passed in the more highly-developed countries, and their railway systems were considered in the main to be complete, so far as the number and extent of lines were concerned. Hence, the planning of railway networks, their scope and configuration, may be said, in most countries, to have been done with due consideration to the economic, techni-

cal, and social conditions that prevailed in commerce and industry and in the sphere of transport during the latter half of the nineteenth century. The railway systems thus planned were confronted after 1920, with completely changed conditions both with regard to the magnitude and nature of the demand for transport facilities, the relative monopoly enjoyed by the railways, and the technical, financial, and social requisites for operating them.

If we disregard those changes in the railway systems that were necessitated by the revision of frontiers in Europe, we find that the process of adjustment to these altered conditions did not, broadly speaking, involve any changes in the scope and configuration of the railway networks, but was rather designed, through intensified technical and commercial rationalization, to increase the efficiency and competitive power of the railways, primarily in relation to the rapidly expanding road transport facilities. In most countries motorized road traffic began to assume major proportions in the early nineteen-twenties. As the highways were gradually expanded and improved and advances were made in the technical field, so did trucks — which at the outset were used only for local and short distance haulage — progressively come into use for increasing distances, i. e., in such spheres of the transport market as had hitherto been dominated by the railways.

The heightened competition between railways and road transport, especially during the great depression of the early nineteen-thirties; the threat that road transport apparently constituted to the financial position of the railways; the pessimism as to the railways' future that was often expressed even by their own managements; the widely-held view that the railways were an obsolete and declining industry and that road transport was in a position to take over most of the transport work of the railways — all these considerations entailed, in most countries, a far-reaching progressive reduction of the railways' capacity (rolling stock, personnel, etc.) in pace with the declining volume of traffic. In this process of adjustment the question of reducing the scope of the railway networks, or their operation, in many cases became ripe for consideration. In general, however, this adaptation process at the outset assumed the form of a consolidation of the railway systems, either by private mergers or by nationalization to a major or minor extent. In the railway network that were thus consolidated, the adaptation was continued to some extent either by closing down relatively unprofitable lines or by introducing simpler and cheaper modes of operating them. In many cases railway traffic was replaced by road traffic, usually owned or supervised by the railway.

In the adaptation process of the railways to the changed conditions, many measures were carried through not only to meet competition from road transport, but also to effect operating economies, accelerate train schedules, develop additional traffic, etc. Store-door collection and delivery of railway freight steadily increased in most countries. Train speeds were raised considerably, this being found one of the most effective measures in the competition with road transport. In order to make these higher train speeds possible, many countries installed modern high-speed railway equipment, electrified their more important main lines, improved their roadbeds, introduced motor rail cars, etc. Many new developments in the commercial field also came into being during this period. The process of general revision of passenger fares and freight-rate schedules with the object of efficiently meeting the changed conditions in economic life and in competition from other means of transport, which process is still going on all over the world, started during the nineteen-twenties. The introduction of modern sales methods and public relations work of different kinds also belongs to this period.

The most important part of this adaptation process by the railways was, however, their work to increase the efficiency of

their operations by rehabilitating certain sections and abandoning other sections of their existing lines, constructing new ones to establish more efficient train services, and electrifying, motorizing, or dieselizing others. The attitude of the railways may be best illustrated by the following quotations from a resolution of the thirteenth session of the International Railway Congress Association in Paris, 1937, on the question of « Effects of the world crisis and road competition on the railway position, and the corresponding changes in railway commercial policy » :

« ... Under rational organization, road transport should be complementary to, rather than competitive with, rail transport. It should, therefore, only be encouraged to the extent to which it is essential and affords a type of service not possible by rail. It is desirable, in particular, that special care should be taken to conserve long-distance and heavy traffics to the railways, whose economic status should in the general interest be preserved. »

« On those services where working is to be continued by the railway, the improvement of passenger facilities, by increasing the speed and frequency of trains, as well as improvements in their comfort, have proved to be efficacious means of meeting competition, and it is desirable to continue in this direction. »

« On the goods side, experience has shown that regularity in delivery times, acceleration of transport, and extension of door-to-door facilities, are excellent means of increasing traffic, and should be adopted wherever possible. »

« The experience gained by the different railway administrations has shown the benefits obtained from suitable advertising and general propaganda. It is most desirable that all forms of advertising and propaganda be developed, that canvassing for traffic be intensified, that closer contact with clients be obtained in order better to understand their wishes and needs, and keep them informed as to the various possibilities and advantages to be derived from the use of the railway. »

« Speaking more generally, railways must continue to follow the commercial methods which have been proved sound in other spheres of business, especially since they now no longer enjoy a virtual monopoly of transport. »

« It is also particularly desirable that railways introduce methods designed to encourage the interest of employees in the development of traffic and the economic position of the railway service. »

So far as the less-used railway lines were concerned, the process of adaptation was neither so rapid nor so far-reaching as might have been expected in view of the swift fall in their traffic volume. This was due not only to the sluggishness that characterizes railways in this respect and that is understandable in view of the predominance of fixed expenditure; for the limit of profitable operation of such lines had shifted toward lower traffic densities as a result of the technical trend, including electrification of the main lines, the introduction of motor rail cars and rail buses, and simplified and less expensive methods of operation. Efforts by the railways to abandon such sections of the railway network as constituted, notwithstanding all rationalization measures, a substantial economic burden often failed because of the opposition of vested interests in communities, labour or local governmental bodies, all interested in maintaining the status quo.

Since World War II, State influence has been accentuated in ever wider spheres in the majority of countries. With regard to transport services this has entailed, in most cases, full nationalization of the railways either by direct incorporation in the State administration or by merger with undertakings largely under State control. In several countries other transport facilities, primarily road and air, have concurrently been subjected to more far-reaching State control in various respects than before.

As a result of this increased State control, the balance between the various means of transport embodied in the system as a whole, as well as the adaptation of the transport system to current demands, have undoubtedly come to be influenced to a high degree by the aims of the State's general economic policy, for instance with regard to the magnitude and purpose of investments, re-development of congested urban areas, decentralization or dispersal, both of industries and population from such areas, encouragement of a reasonable balance of industrial development in the different regions of a country, together with an appropriate diversification of industry in the various regions. These are problems which have been dealt with in most countries during the last 10-15 years. Among possible measures to establish the desired aims of national policy, as regards e. g. investments, regional development and diversification of industry, opening up of resources in new areas of undeveloped regions or countries, transportation factors have often been of paramount importance. During the economic depression of the nineteen-thirties large-scale programs for maintenance and improvement of the permanent way, construction of double tracks, electrification, etc., were devised in some countries as a part of the government's unemployment-relief programs. Measures in the transport field have also been discussed or applied as instruments of government policy to influence location and development of economic activities in different regions of a country, e. g. with the aim of securing better locational balance and diversification of industries between different regions of a country. A government may affect industrial location and development by building or providing means or by granting subsidies for construction of new railways, highways, waterways, etc., by regulating rates and service standards, etc., by subsidies to make possible cheaper transportation in certain areas or for certain kinds of traffic, e. g. workers, schoolchildren, certain agricultural products, etc. National equalization of freight rates between different regions is nowadays established in most countries, usually effected concurrently with nationalization of the railways. Even in U. S. A., with its private enterprise railways, there will soon be, according to a recent decision by the Interstate Commerce Commission, a single basic freight-rate structure, composed of a uniform freight classification and uniform rates, applying to freight traffic, moving under class rates for that part of U. S. A. roughly east of the Rocky Mountains. Only a minor part of freight traffic moves, however, under class-rates — about 2.5 per cent of all carload shipments. The bulk of freight traffic moves under commodity and exception rates and is not touched by the new regulations.

The growing responsibilities of governments during the last few decades, in bringing about as favourable conditions as possible for the establishment of a high level of economic activity and employment, a rising standard of economic efficiency and a rising standard of living, and the growing complexities of economic life, have made a greater measure of foresight, planning coordination and intervention by governments necessary than before. National planning, national budgeting and long-term economic development programs are nowadays common concepts in most countries.

Such long-term economic development programs are deemed to be of great value in the efforts to balance the national economy. They are of further importance as a basis for the coordination of economic policy, particularly with regard to the magnitude and purpose of investments in various fields. Such programs also take into account the probable future needs of investments on various transport facilities.

Governments in many countries have also instituted regional development programs, e.g. the Tennessee Valley Authority (TVA) in U. S. A. one of the main purposes of which is the development of industry in the TVA region. Such major or minor

development areas, for which governments, cities or local communities have established promotion plans, occur in all countries.

This expansion of economic analyses and prognoses in various spheres of economic life unquestionably facilitates the rapid surveying of those trends and structural changes that may come to influence the magnitude and nature of the demand for transport services; wherefore it should now be possible to carry out more smoothly and effectively the adjustments of the transport system to changes occurring in that demand.

Even if the requisites for effective adaptation of the railways to the prevailing needs have thus been improved in principle, some difficulties nevertheless remain in regard to the practical realization of such measures. In countries where the railways have been completely nationalized or placed under State control by other means, the railways are often subjected to political or social demands the fulfilment of which might constitute a substantial economic burden to them. However, a tendency can be observed — even in countries with railways operating under State control or State supervision — to allow the railways on an increasing scale to conduct their activities on business-economical principles — which fact may be expected to ensure a more economically rational adaptation of the transport system to the existing needs.

In shaping their business policy the railways are often shackled in important respects by social-political or general economic-political conditions. In State controlled railways, for instance, the salary- and staff-policy is usually subject to a system comprising the entire state administration, and the tariff policy and acquisition and disposition of capital subject to government resolutions. Even social legislation, etc. may necessitate undertakings by the railways which serve to limit their possibilities of applying purely business-economical principles in their activities.

To sum up, the question of modifying an existing railway system by closing down old lines or by constructing new ones may be said to constitute one facet of the problem of keeping the transport services adapted to changes in the scope and nature of the demand on them. So far as the railways are concerned, such adaptation usually takes a considerable time. The radical change in the scope and nature of this demand, which has now appeared in relation to the days when the railway systems in most countries assumed the structure as to number, course and configuration of lines that they still have in the main; the advent of new means of transportation, automobiles, pipelines, electric power transmission, etc., which, besides fulfilling new requirements, also took over transport work previously executed by the railway; changes in the technical and economic structure and in the geographic distribution of production (urbanization and suburbanization; trends towards small- or large-scale undertakings; substitution of new materials and products for older ones, etc.); and the mounting tendency to apply purely business-economical principles in determining the size and capacity of railway establishments — all these structural changes in economic life have necessitated general supervision and adaptation of the various elements of the business policy of railways, e. g. policy on the closing down or construction of lines, stations and other facilities, or on rates and methods of production, etc.

The planning of the location and course of the individual lines of a railway net was in almost every country made piece by piece and not coherently. As mentioned earlier, the railway systems in more industrialized countries were, in principal features, built out as early as the beginning of the twentieth century, and even if there have afterwards been carried through certain structural adjustments of the national railway systems, adding on of certain complementary lines and closing down of certain lines that have lost their significance, the important changes in structure that have occurred in commercial life and in transportation since the end of the nine-

teenth century, mean that, even if the configuration of the railway net from the beginning would have been reasonable from an economic standpoint, it could now economically be drawn up in a more rational way. New conditions have arisen requiring new measures. What was good in 1870 and 1910 may be inadequate in 1950, and what is good now will probably be quite inadequate in 40 years. Instead of the earlier planning piece by piece of the lines of a railway net the aim of the planning must now be to lay down the totally required traffic routes, i. e. the traffic net as a whole, of a region constituting an economic unit. Regions of various size can there be concerned, e. g. the transport routes within a city, or the routes within the influence region of a densely populated district, within a large geographic region, or within a whole country. With respect to countries, this total planning of the traffic net will be applicable principally for undeveloped ones. But in countries with well developed economic life and railway system it may also be advantageous to adopt this aspect of planning traffic routes in their entirety with a view to finding out what is wrong with the existing net and how it could suitably be improved by constructing new lines or closing down existing ones. Such a revision and examination of the line planning is urgent both for countries where lines were built piece by piece without a comprehensive plan and for countries where, before starting the railway building, they drew up more or less detailed plans for a railway net embracing the whole country.

II. Factors determining the original structure of railway systems with respect to location, number of lines, etc.

From the very outset the railway networks in different countries were planned and constructed to a large extent with the direct or indirect cooperation of the State.

In certain countries the State itself undertook in principle to construct and operate the railways; this was the case, for instance, in Belgium, various German states, Austria, South Africa and Australia. In other countries (the Netherlands, Sweden) a mixed system arose, certain lines being constructed and operated by the State, and others resulting from private initiative, though with a certain amount of State control with regard to construction and operation.

Lastly, in some cases (Great Britain, France, U. S. A., etc.) the State adopted the policy of leaving the construction and management of the railways to private companies, but intervened by means of subvention or other encouragement to stimulate private enterprise in those cases where the lines had to run through parts of the country where traffic was not sufficient to give an adequate return on the capital invested.

This stimulation of private enterprise was accomplished by different means in different countries. In some a subvention in money was given; in others the State acquired a certain proportion of the shares, supplied a certain part of the capital on favourable terms, guaranteed a minimum amount of interest on capital invested, granted land to aid in construction of pioneer railroads or exempted the railway companies wholly or in part from taxation.

The first railways may generally be said to have been built piece by piece, under no comprehensive plan and without any long-term considerations as to fitting in a national railway system. Only in a few countries, including Belgium, France, the Netherlands, Austria, some German states, and Sweden, were there devised, at an early stage of the epoch of railway construction, government-approved plans relating to the location and course of the main lines, and sometimes the branch lines too, in the national railway systems.

As an example of such planned expansion of the railway network, an account will be given here of the development in Sweden. A far-sightedness rather unusual

in railway construction history was shown by the Swedish parliament (Riksdag) at the beginning of railway construction in Sweden a century ago. At its 1847-48 session the Riksdag declared in principle that there should be a nation-wide railway system with the State taking the lead in its construction.

Thus the construction of the Swedish Railway network was based from the outset upon the fundamental principle that the State must occupy a prominent position in this section of the system of communications. At the 1853-54 session of the Riksdag it was resolved, as a general rule to be adopted in Swedish railway policy, that the main lines — the trunk lines — should be constructed and operated by the State, whilst the building of other railway lines should mainly be left in the hands of communal interests or private companies. It is beyond question that the Swedish railway network would never have attained its present wide ramifications for local traffic if the State alone had been responsible for its development. Communal interests and private companies contributed in no small degree to the construction of the greater part of the country's railways, in some cases with State support. This will be realized from the fact that 69 per cent of the existing railway network was built by private enterprise, and 31 per cent by the State.

The entire control of railway constructional work resolved upon by the Riksdag of 1853-54 was entrusted to Colonel Nils Ericson — a brother of the inventor, John Ericson — who also drew up a scheme for laying out the trunk lines which was mainly followed subsequently. On December 1, 1856 it was possible to open the first sections of the trunk lines for traffic. The principle trunk lines in southern and central Sweden were completed rapidly during the eighteen-sixties and early seventies, and the work of railway construction was then extended northwards.

In the meantime certain departures, in both directions, have been made from the fundamental principle laid down by the Riksdag in 1853-54, inasmuch as the State on the one hand constructed branch railway in the sparsely populated northern areas of the country (Norrland), and on the other hand also granted concessions to private railway companies for trunk lines in central Sweden. The first-named departures were due partly to military reasons, but primarily to the fact that the urgent need of railways for the economic development of those parts of the country could not possibly have been met by private initiative, since these railways known as development railways, could not be expected to be commercially remunerative, and thus could not have been carried out without the intervention of the State. As a result of the other departure, namely, the construction of trunk lines by private enterprise, investigations concerning the State acquisition of private railways were made as early as the eighteen-eighties, having been mainly influenced by the principle of railway nationalization adopted in several countries. A comprehensive series of investigations in this connection was carried out throughout the nineteen-twenties and also during the thirties, and resulted, in 1939, in the resolution of the Swedish Riksdag to adopt the principle of nationalizing the Swedish private railways. Since that time most private railways have been incorporated in the State network.

The first railways mainly carried passenger traffic, and it was not thought that railways would be able to compete with water and road transport in the carriage of freight, except where speedy delivery was of importance.

Freight tariffs were high, and as long as the railway network consisted of short and separate lines the volume of freight traffic remained small. With the mounting number of lines and the advent of through-traffic over longer distances, technical and economic considerations necessitated the consolidation of these short lines to form larger railway systems. This rationalization process, which resulted in substantial sav-

ings in rolling stock, administration, etc., and which often resulted in lower fares and rates as well as other benefits in speed and punctuality, also increased substantially the competitive power of the railways in relation to water transport.

This initial consolidation process, creating larger railway systems out of various smaller lines, started about 1850 in most of the older railway countries. Ever since the development of railways there has been everywhere a continuous process of unification, coordination and consolidation of railway facilities and services.

As mentioned earlier, charters for private enterprise construction of railways were, at the outset, mostly for short independent lines. In Great Britain, charters averaged only about 15 miles in length, and in 1847 there were several hundred different railway companies with a total mileage of 5 000 miles. Through consolidations they had been brought down to twelve companies with a mileage of 13 000 miles 25 years later. Railway development has in most countries been a process toward unification of individual railway lines to major systems. Most of the large railway systems in the world today are the result of such consolidations. In U. S. A., one of the earliest consolidations was the merger of eleven different companies, to form the New York Central line between Albany and Buffalo in 1851. Through subsequent consolidations the New York Central System has grown to its present size and is now made up of what were once hundreds of individual railway properties. All other major systems in U. S. A. have come into existence in the same way. In France, the independent railway systems, amounting to 33 in 1847, were consolidated to eleven in 1852 and six in 1859.

Nationalization may be regarded as a special form of such consolidations; and in most countries adhering to or turning to the State railway principle the State has acquired most of the existing private railways. Thus in 1950 the proportion of State railway systems in the total length of railways amounted to about 90 % in Austria, 51 % in Denmark, 85 % in Germany (Western Zones), 75 % in Italy, 98 % in Norway, 92 % in Sweden, 57 % in Switzerland, and 100 % in Turkey and Great Britain. As an example of a consolidation process of this type it may be mentioned that in Sweden the privately constructed railway network originally comprised 336 railway properties. Through nationalization of 55 and closing down of six properties they had, in 1937, shrunk to 275 properties, consolidated in 98 railway companies. Of these companies, 61 were combined under a common management in 23 major systems, representing about 95 % of the total traffic of the private railway systems. Since the nationalization resolution of the Swedish Riksdag in 1939, most of these private railway companies have been incorporated in the State railway network.

The economic requisites for railway construction showed substantial differences in different countries. At the start of the epoch of railway construction certain countries, such as Great Britain, Belgium, and France, had well developed industries and commerce, with good roads and canals. The railways in these countries were mainly designed to further existing business. Railways in such countries often came to replace, either wholly or in part, previously existing traffic routes (canals, roads, etc.). Capital was abundant and railway lines of a high technical standard could be constructed. When the railway systems were expanded and operative methods improved, it became increasingly necessary for the railways to increase their volume of traffic by adopting a flexible rate policy. The traffic attracted by the lower rates introduced by the railways, especially for low-class traffic, was partly drawn from previously existing modes of transport, waterways and road traffic, and in part created by the new railway services.

In other countries, railways were built mainly with a view to developing new lines of transport in areas where industry

and trade were very limited. Such principles in the laying out of new railway lines were applied e.g. in U. S. A. and Sweden, and have also been common for undeveloped areas in other countries. Some railways of this type have been built for political or military reasons. These railway lines of a pioneering or development character were built in advance of settlements, creating the communities which were to support them with traffic. Capital for the most part was scarce, and the lines had to be built as cheaply as possible or there would be no railway at all. The technical standards of such lines were often very simple, with heavy grades and sharp curves, light rails, etc. A. T. Hadley (1) has characterized the development in U.S.A. in the following way: « In America the question how to build such roads took care of itself. Land was cheap; wood was cheap; it only remained to select such a course as would involve the least outlay for grading, cuttings, or bridges; put down sleepers on the ground itself, lay the cheapest rails that would hold together, and trust to the future for any more solid construction. » As traffic on such lines grew, so did operation costs mount to such a degree that it was worth while improving the technical standards. Such improvements, which usually involved total reconstruction of the lines, necessarily were very expensive.

In more highly developed countries, the first railways were usually designed to establish communications between major centres of industry, commerce, or administration. It was then largely a case of linking the capital with other large cities.

In planning the location and course of new lines the existing traffic routes, primarily waterways, were sometimes taken into account insofar as the railways were laid, not so as to run parallel with such waterways, but to intersect them or link up with them at certain points, so that railways and waterways largely came to complement each other. This policy was adopted because, during the first few decades of railway construction when the traffic volume on existing lines was still small and the operative methods very imperfect, it was not thought that a railway running parallel with a waterway would be able to compete with it. Hence the choice of location and course during this period was also characterized primarily by consideration to the needs of passenger traffic.

Yet in most cases the location and course of railways were determined with but little regard to existing traffic routes, especially roads. For natural reasons the railway planners usually sought to follow the major highways, which corresponded to old commercial routes adapted to the country's economic and geographic structure.

Lastly, the location and course of new railway lines, especially in undeveloped areas or countries where communications were either absent or very imperfect, were sometimes determined solely by the aim of developing commerce and industry in the regions they served (« break-ground » lines, pioneering lines, development lines). An important subsidiary reason for the construction of such pioneering lines often lay in military or defence considerations.

In general the location and course of new lines and the technical standard of the railways were largely determined on business-economical principles, especially as regards lines constructed on private initiative. With State-constructed lines, however, commercial political or military considerations, too, often played an important role.

From the business-economical standpoint it was usually a matter of selecting, from a number of possible locations and technical standards that might satisfy the anticipated and future traffic demands in the relevant districts, one that would provide as favourable a relation as possible between anticipated operating costs and income from traffic. In private enterprise construction it was necessary here to secure

(1) A. T. Hadley : *Railway Transportation*, 1906, p. 14.

a surplus above operating costs that permitted a satisfactory interest on the capital invested. Similar aims of policy were usually applied in State railway construction especially with regard to lines with heavier volumes of traffic.

At the outset of the epoch of railway construction, railway charters and railway construction schemes, as mentioned earlier, usually embraced relatively short lines. Many of the first railway lines were built from towns or ports with the primary motive of expanding the markets for their products and extending the areas supplying them with agricultural products and raw materials. Railway lines were, during this period, only of local importance. As the railway lines increased in number and were extended in length, thus making possible longer distances for through-transport, so did there develop, in countries which had not gone in for State railways at the outset, competition between different railway companies to reach important regions as a further major motive for continued expansion. This form of competition was perhaps most pronounced in U. S. A. and in Canada.

The economic and technical planning of new railways was often very thorough. Estimates of the anticipated traffic volume of the projected line were often based on the actual traffic on existing roads and waterways which might be expected to be transferred to the railway. Moreover it was usually assumed that the cheaper and speedier railway transportation would serve to increase the volume of traffic. Since the projected railway might serve as a through-route or make possible the exploitation of new sources of raw materials or the establishment of new industries, further traffic could be counted on.

Where experience had been gained of the traffic trend on earlier constructed lines which approximated to the projected line with regard to its geographic, economic, and technical aspects, the traffic on this new line could be estimated on the basis of the known traffic densities. In so doing, the traffic-promoting capacity of the various stations was usually taken as being proportional to the populations of the relevant places served and their environs. On the basis of the specific transport needs per inhabitant in various types of places served by railways, the total traffic volume of a new line could thus be estimated. In 1868, the French engineer, MICHEL [1], estimated that in France the average departing railway traffic for various types of places served amounted to between 4.0 and 9.0, with an average of 6.5, journeys per inhabitant per annum in respect of passenger traffic, and between 1.4 and 3.0, with an average of 2.1, tons of goods per inhabitant per annum in freight traffic. The higher traffic densities applied to towns and other densely populated places served by railways, and the lower ones to more sparsely populated places.

Such data on the average volume of traffic required per inhabitant in places of varying size and economic structure were subsequently used in most countries to implement direct and more detailed estimates of the traffic volume in the planning of new lines. Estimates of this or similar type were made by e.g. CAMPIGLIO (1872) in Italy, PLESSNER (1870), RICHARD and MACKENSEN (1883), and LAUNHARDT (1883) in Germany, and WELLINGTON (1887) in U. S. A. All such estimates were of course based on the existing conditions and could be employed only in respect of technical and economic conditions corresponding to those on which they were based.

When the traffic volume of the projected railway had been estimated with respect to size, structure and future development, and assumptions had been introduced regarding passenger and freight rates to be applied, the volume and the total income from traffic could be estimated.

Subsequently it was a matter of determining, with due consideration to the above

[1] MICHEL : « Sur le trafic probable des chemins de fer d'intérêt local », *Annales des Ponts et Chaussées*, 1868.

findings, the technical requisites (gauge, gradients and curves, weight of rails, etc.) as well as the location and course, so as to make the total costs of establishing and operating the line throughout its life span as low as possible. In seeking the optimal total costs, the difficult problem arises of adjusting initial outlay and operating costs with respect to the future development of the traffic, i.e., of devising such a technical framework that the establishments can later be expanded or, if necessary, reduced in economically advantageous stages. Yet such an adaptation of the technical arrangements for each individual line is not always practicable, since the line in question may be part of a larger railway network the technical structure of which must, for economic and practical reasons, have a certain uniformity. This uniformity usually applied primarily to the gauge. But with regard to such lines as were mainly of local importance alone, economic considerations sometimes justified a departure from uniformity and the choice of a narrower gauge. With other lines of uniform gauge, it was sought, at least in certain countries, to adapt the technical standards (gradients and curves, weight of rails, etc.) to the respective traffic densities. The usual procedure was to classify the sections with respect to traffic density and to lay down uniform principles for the technical details of the establishments in each particular class. This economically motivated differentiation in the technical equipment of the lines, at all events insofar as European railways were concerned, was not sufficiently observed until fairly late in the history of railway construction. Sax, for instance, states that in the technical standards applied by the Association of German Railroads no distinction was made between main lines and secondary lines until 1873, and it was not until 1886 that special provisions for the construction and operation of local lines were incorporated in those standards; which shows, according to Sax, « that economy in this respect was of secondary importance in relation to technic, in the establishment of part of the German and Austrian railway system ». Probably the circumstances were much the same in other western European countries around that time.

This striving for uniformity in the technical standards of the various lines mainly characterized state railway construction. In this way, the technical standard of light traffic lines became, in certain cases, excessively high from the economic standpoint, at least in relation to the conditions then obtaining. By departing from the principle of uniform gauge and employing a narrower gauge for light traffic lines that were mainly of local importance, the initial outlay could be substantially reduced.

According to Liebmann ([1]), experience of German railway conditions in the latter half of the nineteenth century indicated that the initial outlay on railway lines with gauges of 1435, 1 000, 750, and 600 mm stood in the ratio of 100 : 67 : 58 : 33. The costs of operating the three narrow-gauge lines, at the relatively low traffic densities associated therewith, did not differ to any substantial degree either from each other or, regarding lines carrying beside passenger traffic largely local goods traffic, from the costs of operating normal-gauge lines. But if any major amount of goods traffic occurred to stations outside the narrow-gauge sections, reloading costs rose, so that the operating costs of that particular section might be higher than if it had been normal-gauge. On the other hand, the operating costs could be substantially lower than those for normal-gauge lines if the traffic on the narrow-gauge section mainly consisted of passenger traffic.

This possibility of reducing initial outlay by the use of narrow-gauge lines was exploited in many cases, particularly in countries where capital was scarce.

Private railway construction, the primary aim of which was more to secure a satis-

([1]) Liebmann : *Zeitschrift für Kleinbahnen*, 1902, p. 148.

factory yield on the invested capital, probably applied in general a far-reaching differentiation of the technical standard of the permanent way, rolling stock, and other facilities with respect to the magnitude and structure of the existing traffic. This differentiation, which might also be called « want of uniformity in the technical structure », often became necessary because sufficient capital could not be secured to carry through a railway project in the way originally envisaged. In the long run, an unduly limited adaptation of the technical standard to the existing traffic might entail substantial financial risks; namely, if the traffic increased to a greater extent than had been foreseen in the original plans. In such a case a very unfavourable position with regard to operating costs might arise until such time as the technical capacity and standard could be adapted to the higher volume of traffic.

Purely business-economical considerations have probably determined in great part, especially in U. S. A., the establishment of railway lines and their technical capacity and standard. Other motives too have naturally played a role, both there and in other countries. Among such driving forces in railway construction may be mentioned the competition between different towns or regions for new markets or sources of raw materials opened up by the advent of railways. Another stimulus to railway construction in U. S. A., of importance particularly in the West, was the desire of railway promotors to increase land values; and their interests were often as much in land speculation as in railways.

As early as 1841, Charles Ellet Jr., in a pamphlet « Exposition of the causes which have conduced to the failure of many railroads in the United States », strongly emphasized the importance of adapting both technical standards for construction and operation standards with respect to the volume of traffic on the railways.

Ellet's view was that engineers had perfected the art of construction but had neglected to consider sufficiently the economic problem of how different factors influenced profits of the railway. He considered that unprofitable railways were characterized by too elaborate facilities in proportion to the existing volume of traffic and illustrated his reasoning by the following example :

« A stage proprietor has two routes on which he is compelled by contract to carry the mail and all passengers who apply; on one of which he knows that there will be at least ten persons and a large mail every day; and that to accommodate the public satisfactorily, he must employ a Troy-built stage, and four good horses, adequate relays, and skilful drivers. He knows, too, that on the other — a remote and obscure route — there can never be more than two or three passengers, frequently none at all, and a mail-bag equal to a school-boy's satchel, all of which could be conveniently carried in a light one-horse wagon. But, being conscious of the dignity of his calling, and ambitious to sustain it; and having, withal, certain preconceived notions of what constitutes a « stage line », he determines, at once, to put four-horse coaches on both routes. With a knowlegde of these facts, should we be surprised to hear him affirm, at the end of a year, that it does really cost very nearly as much to run his team on the obscure line as on the popular throughfare — to drive his heavy and empty four-horse coach over its daily route as it does the full one — or to hear him complain that staging is a losing business ? »

About fifty years later A. M. Wellington was to treat the same subject in his « The economic theory of the location of railways » (1887), with the subtitle « An analysis of the conditions controlling the laying out of railways to effect the most judicious expenditure of capital », which study was for long the American standard work in this field. According to Wellington, « it would be well if engineering were less generally thought of, and even defined, as the art of constructing. In a certain important sense it is rather the art of not constructing, or to define it rudely but not inaptly, it is the art of doing that well with

a dollar, which any bungler can do with two after a fashion ». As to such engineering as is needed for laying out railways, Wellington says « the definition given is literally applicable, for the economic problem is all there is to it ».

The conditions governing economically sound railway constructions have seldom been so clearly and ably stated as in the work of Wellington. Whether the motive of construction is direct pecuniary profit or only indirect gains of some sort to investors and the public, the same general law holds for the construction, according to Wellington: namely : « It is the plain interest of the constructors, in all cases, to obtain as good a road as they can for the money, and to build it on business principles; to spend what they have to spend to the very best advantage, and to spend no more than they are obliged to spend to build the line at all in safe operating condition, unless the additional expenditure, and not simply the expenditure as a whole, is clearly a good investment ». As regards the technical standards of construction Wellington holds that the *a priori* basis on which the construction of every line should be entered upon — however prosperous the company, however large the probable traffic and profits — is : « That excepting when and as specific reasons to the contrary appear, the cheapest line is to be built over which it is physically possible to carry the probable traffic with proper safety and speed, using to this end any grades and curves and length of line which may be most conducive to this end only — and never abandoning it by increasing the expenditure, unless the investment — not the investment as a whole, for the line as a whole, but each particular investment for each particular purpose at each particular point — will be in one way or another profitable in itself. » — Wellington particularly stresses that this does not mean that construction should be « cheap and shabby »; it simply means an avoidance of waste and « recognition of the fact that every dollar and every day's work which goes into the ground and does not bring something out of it, makes not only the individual but the whole community the poorer ».

The fundamental conditions for economically sound construction standards, as set forth by Wellington, naturally apply also to operation standards and to investments in improvements of or additions to existing railway facilities; namely, the balancing of additional costs for improved operation standards against accruing additional traffic revenues, and the balancing of additional investment costs against savings in operating costs and possibly accruing additional traffic revenues.

Wellington has been treated at some length here because, according to Mr. Ralph Budd (1), President of the Burlington Lines, he « had great influence with railroad engineers during the era of most active expansion of railway mileage. — Railway location and construction generally was carried out during this time according to sound economies. In other words, the balance between higher construction costs and lower costs of operation was scientifically considered. When the first cost was too great to be assumed at the time of construction, a final line was located then, but the roadbed was often built on temporary alinement and grade, to serve until the permanent route could be financed. Hundreds of miles of railway lines were rebuilt, in some cases more than once, as the value of better grades and curves was demonstrated, and partly also because of growing volume of traffic ».

The development of most European railways was about the same during this period. After a period of extensive development, with rapid construction of new railway lines during the eighteen-sixties, seventies and early eighties, when railways were in the main concerned with the problems of construction, there followed a period of more intensive development, dur-

(1) Address by Mr. Budd at the 48th Annual Meeting of the American Railway Engineering Association, 1949.

ing which the railways were more occupied with questions of efficiency in operation, improving and implementing their facilities.

III. The different stages of railway development.

In the older countries of the world the development of railways has passed through several distinct stages. To a certain extent, these stages show the same time pattern and development as the long waves (trend cycles) in economic life. Many important factors in economic life, such as production, wages, and prices, underwent, in most capitalistic countries during the nineteenth and twentieth centuries, such long waves extending over a period of fifty to sixty years; and superimposed on them were ordinary business or trade cycles. These long waves are usually dated as follows ([1]) :

« *First long wave* :

1) the rise lasted from the end of the seventeen-eighties or beginning of the nineties until 1810-17;
2) the decline lasted from 1810-17 until 1844-51.

Second long wave :

1) the rise lasted from 1844-51 until 1870-75;
2) the decline lasted from 1870-75 until 1890-96.

Third long wave :

1) the rise lasted from 1890-96 until 1914-20;
2) the decline probably began in the years 1914-20. »

The turning points in the specific stages of railway development are about the same as those in the long waves of economic life. Railway construction is considered to have been a major contributory factor in economic activity and development, especially during the second long wave, 1850-1895.

The *first stage* of railway development, from about 1830 to about 1850, was a period of preparation and experiment as regards both technical methods of construction and operating and methods of financing and management.

The *second stage*, from about 1850 to about 1895, was the period of extensive development of railways. During this period the more important through lines were completed in most countries. The most rapid expansion occurred in the boom period preceding the economic crisis of the eighteen-seventies and in the eighteen-eighties. Between 1865 and 1875 the length of railways increased by about 70 000 km in Europe and by more than 70 000 km in America. Between 1875 and 1895 about 100 000 km was added to the length in Europe and more than 200 000 km to the length in America (*Table I*). By about 1895 the railway networks of the more developed countries had been expanded to such an extent that they almost completely covered the area of the country.

The *third stage*, from about 1895 to about 1920, can broadly be characterized as a period of intensive development of existing railway lines. The railway networks of the more developed countries being almost complete, the need of territorial expansion decreased and instead, as a result of the rapidly growing industry and trade, the need of intensive development of existing lines became urgent. Therefore during this period the railways were primarily engaged in increasing the capacity and efficiency of existing lines, involving, in the main, construction of feeder and cross lines, multiple tracks, additional yard tracks and sidings, and generally a rounding off of the existing railway networks. In most countries the networks reached their greatest extent about 1920 and have since been slowly decreasing.

The *fourth stage* began about 1920 after

([1]) KONDRATIEFF : « The Long Waves in Economic Life », *The Review of Economic Statistics*, 1935.

World War I. and can be said to be still proceeding.

While before that time railways on the whole had monopolized land-transport, they were subsequently to face steadily increasing competition from road traffic, particularly with regard to valuable high-rated goods. At the same time the economic fluctuations were accentuated and a great number of structural changes in commercial and industrial life caused considerable changes in the structure of railway traffic. As a result of these structural changes the earlier, relatively quiet development of the railways during their « period of monopoly » was followed by a more dynamic development, in which railways had to fight for their traffic in hard competition with other means of transport. Whereas during the period of monopoly, which period at the same time was that of construction and development of the railway networks, the technical issues involved the main railway problems, nowadays, mainly as a result of competition and of more dynamic conditions in economic life, economic and technical-economic problems have become predominant in railway business policy. Now more than ever, this policy must also take into account the different interests working inside and outside the undertaking; that is to say, the scope of social and broadly political aspects has increased, besides that of economic and technical ones.

Mainly as a result of competition from road transport, many thousands of kilometres of railway lines throughout the world have been abandoned since the nineteen-twenties.

The development in U. S. A., which possesses a most extensive and efficient transportation system, is of special interest in this connection. In certain respects the U. S. railways have encountered the most severe competition in the world from commercial or private services, highways, waterways, airways, and pipelines. The motorization of highway traffic and the development of air traffic have now reached a

TABLE 1.

Growth of railway length in kilometres by continents and countries 1835-1917.

Continent or country	Year 1835	Year 1845	Year 1855	Year 1865	Year 1875	Year 1885	Year 1895	Year 1905	Year 1917	Year 1929	Railway length 1929 in kilometres: per 100 square km	Railway length 1929 in kilometres: per 10000 inhabitants
Europe	*673*	*8 235*	*34 185*	*75 882*	*142 494*	*195 833*	*238 553*	*309 392*	*351 846*	*408 504*	*1.9*	*8.0*
Great Britain	471	3 277	13 411	21 382	26 803	30 843	33 219	36 447	38 135	39 291	14.2	7.5
Germany	6	2 315	8 352	14 762	28 087	37 572	44 882	56 477	64 987	58 619	12.5	9.3
France	176	883	5 535	13 562	21 547	32 491	39 357	46 466	51 431	53 561	9.7	12.0
Sweden	0	0	0	1 285	3 681	6 892	8 782	12 684	14 951	16 721	3.7	27.5
America	*1 770*	*7 450*	*32 417*	*62 534*	*134 098*	*249 246*	*360 415*	*460 196*	*586 859*	*606 204*	*1.5*	*25.5*
U.S.A.	1 770	7 450	29 566	56 452	119 220	207 508	286 183	351 503	418 768	402 859	4.3	33.9
Asia	*0*	*0*	*350*	*5 489*	*11 332*	*22 285*	*38 788*	*81 421*	*114 123*	*125 924*	*0.5*	*1.3*
Africa	*0*	*0*	*144*	*755*	*2 576*	*7 032*	*12 384*	*26 616*	*48 153*	*68 213*	*0.3*	*5.8*
Oceania	*0*	*0*	*38*	*825*	*3 738*	*12 947*	*21 030*	*28 069*	*36 388*	*49 434*	*0.6*	*63.9*
Total for the world	2 443	15 685	67 134	145 485	294 238	487 343	671 170	905 694	1 137 369	1 258 279	1.0	6.7

Sources : Archiv für Eisenbahnwesen and *Poor's Manual of Railroads.*

more mature stage in U. S. A. than in the rest of the world, where the development of these new means of transport, albeit very rapid in itself, has shown a certain lag in relation to U. S. A. The development in U. S. A. is therefore of some value in estimating the probable future trends in the rest of the world. Naturally, no generalizations are possible, since marked disparities exist between different countries in population densities, in physical and geographic features, and in economic and social development, which must be taken into account. It seems, however, appropriate to give a short survey of the development of the transportation system in U. S. A.

Prior to World War II, the United States had only 6 % of the world's population but one third of the railway mileage, more than two thirds of the passenger automobiles, and more than one half of the motor trucks in the world.

Table 2 shows the development of transport facilities in the United States between 1840 and 1940 (1). Steam railway mileage totalled less than 3 000 miles in 1840, but increased steadily to a peak of 254 251 miles in 1916. Due to abandonments and mileage readjustments after 1916, small decreases occurred up to 1930, and a further and somewhat larger decrease between 1930 and 1940. As a result, railroad mileage in 1940 totalled 233 670 miles, a reduction of 8 % on the peak of 1916.

(1) *Association of American Railroads:* Transportation in America. Washington, D. C., 1947.

TABLE 2.

Development of transportation facilities, United States : 1840-1940.

Year	Railway mileage owned	Gross tonnage employed in coast-wise and internal trade (000)	Motor vehicle registration		Domestic airway mileage	Oil pipeline mileage
			Passenger cars (000)	Motor trucks (000)		
1840	2 818	1 177				
1860	30 626	2 645				
1880	93 267	2 638				
1890	163 597	3 409				
1900	193 346	4 287	8			
1910	240 293	6 669	459	10		
1920	252 845	6 358	8 226	1 006		
1930	249 052	9 723	23 059	3 486	29 887	112 600
1940	233 670	10 352	27 435	4 590	41 054	125 189

Source : Association of American Railroads, Transportation in America.

As to water transport, the total tonnage employed in coastwise and internal trade nearly quadrupled between 1840 and 1900, and more than doubled again between 1900 and 1940. The interwar increase from 1920 to 1940 was from 6.4 million gross tons to 10.4 million, an increase of 63 %.

Highways have been of significance to modern intercity transportation only since the advent of the motor vehicle. *Table 2* shows the growth in number of motor vehicles since 1900. No trucks were registered in 1900, and only 8 000 passenger automobiles. The number of passenger cars (including buses and taxis) grew rapidly after World War I and by 1940 had increased to 27.4 million. The first motor trucks appeared in 1904, when 700 were manufactured. By 1910 the total number did not exceed 10 000 but increased rapidly, to 4.6 million in 1940.

Commercial air operations began in the early twenties. In 1926, domestic airway mileage amounted to 8 252 miles. It increased rapidly to nearly 30 000 miles in 1930 and further to 41 000 miles in 1940. Classified airports numbered 1 891 in 1940, not including 289 intermediate airfields and 151 military installations.

Statistics of early pipeline mileage are very inadequate. The mileage of crude oil pipelines in 1924 totalled 82 832, more or less equally divided between trunk lines and gathering lines. In 1940, crude oil trunk lines aggregated 62 400 miles, crude oil gathering lines 54 500 miles, and refined oil trunk lines 8 300 miles. Total oil pipeline mileage in that year was 125 189 miles. This was supplemented by new construction during the war, much of which was of an emergency nature.

The volume of intercity freight traffic, public and private, in U. S. A., and its distribution among different kinds of transport services, are shown in *Table 3*. The estimated ton-mile statistics include all intercity carriers except coastwise and intercoastal water traffic. Comparison of the ton-mile figures in 1916, before the advent of the motor vehicle on the high-

TABLE 3.

Volume of intercity freight traffic, public and private, in U.S.A. by kinds of transportation.

AGENCY	Millions of ton-miles				Per cent of grand total			
	1916	1941	1944	1949	1916	1941	1944	1949
Airways	0	20	75	236	0	0	0	0
Inland waterways	87 833	140 454	150 155	132 262	18.5	18.6	13.9	15.2
Pipelines	21 000	68 359	133 000	109 655	4.4	9.0	12.3	12.6
Highways	0	64 800	49 300	93 653	0	8.6	4.6	10.8
Railways	367 257	481 748	745 854	534 448	77.1	63.8	69.2	61.4
Grand total	476 090	755 381	1 078 384	870 254	100.0	100.0	100.0	100.0

Source : Interstate Commerce Commission.

ways, with those of 1941 and later years, shows that railways have lost a considerable volume of traffic to highways. During the war years 1942-1945 railways temporarily regained part of the ground previously lost. The railways' proportion of the total volume of intercity traffic decreased from 77.1 % in 1916 to 63.8 % in 1941 and 61.4 % in 1949, while the highways' proportion increased from zero in 1916 to 8.6 % in 1941 and 10.8 % in 1949. The pipelines' proportion increased from 4.4 % in 1916 to 9.0 % in 1941 and 12.6 % in 1949.

Table 4 deals with the estimated volume of intercity passenger traffic, public and private, in U. S. A., and its distribution among different transport services. The important role that automotive transportation on highways (buses and private automobiles) now plays in intercity movement of passengers in U. S. A. is strikingly manifested in the decrease in the railways' proportion of the total passenger traffic volume from 98.0 % in 1916 to 8.0 % in 1949, and the increase in the highways' proportion from zero in 1916 to 90.2 % in 1949. Of the highways' proportion of 90.2 % in 1949, private automobiles accounted for 85.5 units and motor carriers of passengers (buses) for 4.7 units. The airways' proportion of the total volume of intercity traffic increased from zero in 1916 to 1.5 % in 1949, while the inland waterways' proportion during the same period decreased from 2.0 to 0.3 %.

For purposes of comparison with the data given in respect of U. S. A., similar data are shown in *Tables 5 and 6* for a country where motorization of road traffic is not as advanced as it is in U. S. A. *Tables 5 and 6* show how the total traffic volume is distributed between different traffic services. It should, however, be observed that the data for U. S. A. only refer to intercity traffic, while those for Sweden cover intercity as well as local traffic (tramways, city buses, suburban traffic, taxi-cabs). If, as far as Sweden is concerned, only intercity passenger traffic is

TABLE 4.

Volume of intercity passenger traffic, public and private, in U.S.A., by kinds of transportation.

AGENCY	Millions of passenger-miles				Per cent of grand total			
	1916	1941	1944	1949	1916	1941	1944	1949
Airways	0	1 385	2 264	6 761	0	0.4	0.8	1.5
Inland waterways	864	1 821	1 930	1 179	2.0	0.6	0.7	0.3
Highways	0	278 000	184 200	403 906	0	89.6	64.4	90.2
Railways	42 045	30 583	97 700	35 718	98.0	9.4	34.1	8.0
Grand total	42 909	311 789	286 094	447 564	100.0	100.0	100.0	100.0

Source : Interstate Commerce Commission.

TABLE 5.

Volume of all freight traffic (intercity and local, public and private) in Sweden 1950.

AGENCY	Millions of ton-kilometres	Per cent of grand total	Average length of haul in kilometres
Railways	8 640	57	209
Automobile traffic	2 660	17	16
Shipping	2 076	13	324
Wood towage	720	5	80
Timber floating	1 170	8	130
Grand total	15 266	100	

TABLE 6.

Volume of all passenger traffic (intercity and local, public and private) in Sweden 1950.

AGENCY	Millions of passenger kilometres	Per cent of grand total
Railways	6 600	40.6
Tramways	1 300	8.0
Automobile traffic: Private	5 000	30.7
Public	3 200	19.6
Shipping	150	1.0
Airways	2	0.1
Grand total	16 300	100.0

considered, the railways' proportion of this total traffic will amount to about 60 %. Contrary to the American railroads, the Swedish ones still dominate passenger traffic. When it comes to freight traffic the relative importance of the railways of the two countries is about the same. In other west European countries with well differentiated industrial and commercial life, the railways' proportion of the total passenger and freight traffic volume is about the same as in Sweden.

The railways' proportion of traffic varies of course from country to country, depending upon a number of economic and geographic factors such as structure and volume of industry, trade, etc., density and extent of railway networks, roads and waterways in relation to area and population. Some data illustrating the differences in transport facilities in different countries are given in *Table 7*. It has not been possible to include corresponding figures for inland waterways or coastal shipping, but it is clear that the relatively low density of railway lines per 1 000 inhabitants

TABLE 7.

Some data on transportation facilities in different countries 1949.

	1 000 inhabitants per 100 square kilometres	Kilometres of railway lines per 1 000 inhabitants	Motor passenger cars per 1 000 inhabitants	Motor trucks per 1 000 inhabitants
1. *Africa :*				
Union of South Africa	1.0	1.81	38	11
2. *America :*				
Argentine	6.0	3.14	13	8
Bresil	6.0	0.73	4	4
Canada	1.0	4.92	136	52
Chile	8.0	1.92	6	5
U. S. A.	1.9	2.47	262	55
Mexico	1.2	1.04	7	5
3. *Asia :*				
India	10.9	0.16	0	0
Japan	22.3	0.25	0	1
China	4.6	0.03	0	0
4. *Europe :*				
Austria	8.3	0.97	7	6
Belgium	28.2	1.28	32	16
Denmark	9.7	1.19	27	14
Finland	1.2	1.28	7	8
France	7.5	1.28	39	19
Germany (West-)	19.4	0.74	8	6
Great Britain	20.6	0.68	45	17
Ireland	4.3	1.59	25	8
Italy	15.3	0.49	7	5
Luxemburg	11.4	1.67	32	14
Netherlands	29.9	0.36	14	8
Norway	1.0	1.06	19	15
Portugal	9.3	0.37	8	3
Spain	5.6	0.57	3	3
Sweden	1.5	2.44	36	13
Switzerland	11.3	1.28	32	9
Turkey	6.5	0.38	0	0
5. *Oceania :*				
Australia, Commonw.	1.0	5.76	112	59
New Zealand	7.0	3.08	128	43

Source : Statistical Yearbook of Sweden 1951.

in e.g. (West) Germany, Great Britain, the Netherlands and Turkey may be largely explained by the existence of extensive systems of inland waterways or coastal shipping facilities.

The most outstanding feature in road freight transport during the last decenniums has perhaps been the mounting number of motor trucks operated on the traders' own account (private carriers in U. S. A., C-licenses in Great Britain). These trucks are almost wholly engaged in retail delivery and other local transportation. A Swedish survey has shown that 66 % of private truck traffic in the country did not exceed 10 km and 89 % did not exceed 30 km, and that the average haul only amounted to 13 km. The International Chamber of Commerce has recently conducted an inquiry into the extent to which traders operate their own road transport. In many countries the private truck traffic now owns the main part of the total number of trucks available, as can be seen from the following figures :

COUNTRY	Total number of trucks	Number operated for traders' own account	Traders' own trucks Per cent of total
Belgium	130 800	121 500	93
Germany	294 500	196 000	66
Great Britain	801 700	672 300	84
Italy	247 700	189 400	76
Netherlands	68 100	50 100	74
Sweden	83 300	66 200	80
U. S. A.	8 000 000	6 900 000	86

IV. Structural changes in economic life and their relation to the demand for transport services.

The principal factors determining the long-term general economic trend in a country might be summed up in the following five main groups :

1) changes in population and its internal structure (age distribution, regional distribution, distribution between urban and rural areas, etc.);

2) changes in the supply of resources of different kinds (raw materials, land, etc.);

3) changes in the demand for different products and services;

4) changes in technical methods and organization of production and distribution:

5) changes in the economic and social policy of the government.

The way in which changes in these factors influence economic activity in the long run should, in several cases, be more or less self-evident. For instance, an increase of the population usually tends to increase production. A decrease in the supply of an important raw material tends to diminish the output of such commodities in which that raw material is used. Improved technical methods in production, like improvements in the organization of

production and distribution, as a rule lead to increased output.

The demand for transport services is largerly determined by the magnitude and aims of a country's economic activity. The distribution of the total transport demand among the available competing transport facilities and agencies depends upon their relative economy and fitness to perform the various individual transport services.

Since the advent of railway construction the economic life of long industrialized countries has undergone pronounced structural changes. The epoch of industrialization dating from the early or mid-nineteenth century — its advent varied in different countries — is characterized by a progressive change in the urban and rural distribution of the population and its distribution in various branches of commerce and industry. The general trend has been much the same in most countries, though variations of course occur in the timing and intensity of the industrialization process, due to differences in economic, geographic and social structure, etc.

The distribution of population growth among urban and rural areas is an important factor for the development of production, consumption and transportation. The needs and wants of urban populations differ considerably from those of rural populations as regards food, housing, transportation, etc., which causes different processes of distribution and transportation.

The industrial revolution, causing a rapid growth of industry and stimulating the growth of the total population, necessitated a fundamental change in the distribution of population between urban and rural areas. Since the new industries and service industries, which were mostly localized to urban areas, needed labour, while agriculture had a certain surplus of labour that could not be profitably employed, an accelerated shift of population from rural to urban areas occurred, which has been proceeding ever since the mid-nineteenth century in the older industrialized countries. This urbanisation process is illus-

TABLE 8.

Year	UNITED STATES OF AMERICA				SWEDEN			
	Population in thousands			Per cent urban of total	Population in thousands			Per cent urban of total
	Urban	Rural	Total		Urban	Rural	Total	
1840	1 845	15 224	17 069	10.8	304	2 835	3 139	9.7
1860	6 217	25 227	31 443	19.7	435	3 425	3 860	11.3
1880	14 130	36 026	50 156	27.6	690	3 875	4 565	15.1
1890	22 106	40 841	62 948	35.2	900	3 885	4 785	18.8
1900	30 160	45 835	75 995	39.6	1 104	4 032	5 136	21.5
1910	41 999	49 973	91 972	45.7	1 368	4 155	5 523	24.8
1920	54 158	51 553	105 711	51.3	1 743	4 161	5 904	29.5
1930	68 955	53 820	122 775	56.1	1 996	4 146	6 142	32.5
1940	74 424	57 246	131 669	56.5	2 381	3 990	6 371	37.4
1950					3 283	3 764	7 047	46.6

Source : Association of American Railroads, *Transportation in America*, and *Swedish Statistical Yearbook 1951*.

trated in *Table 8* by the development in U. S. A. and Sweden. For U. S. A. « urban population » denotes the population of all incorporated places of at least 2 500 persons, and for Sweden the population of places incorporated as cities. The comparative trends in urban and rural population are about the same for both countries.

The intensity of this industrialization process may be illustrated here by Swedish data (*Table 9*) relating to the distribution of Sweden's total population in different vocational groups from 1870 to 1945. In 1870, nearly three fourths of the population, as will be seen from the table, were assignable to the agricultural group. By about 1900 this group had declined to somewhat over one half, and by 1945 to less than one third of the total population. This implies in absolute figures that the agricultural population fell by over one million during these 75 years. The industrial population, which in 1870 amounted to about 15 % of the total population, had been roughly doubled by 1900 and almost trebled by 1945, in which year it was the largest occupational group. Up to 1920, the proportion engaged in commerce increased at approximately the same pace as the industrial group, whereas that in the

TABLE 9.

Distribution of total Swedish population by occupation 1870-1945.

Year	Agriculture	Manufacturing, mining, etc.	Commerce, communications.	Public services, self-employed, etc.	Total
			Millions of persons		
1870	3.0	0.6	0.2	0.3	4.2
1880	3.1	0.8	0.3	0.3	4.6
1890	3.0	1.0	0.4	0.4	4.8
1900	2.8	1.4	0.5	0.3	5.1
1910	2.7	1.8	0.7	0.3	5.5
1920	2.6	2.1	0.9	0.3	5.9
1930	2.4	2.2	1.1	0.4	6.1
1940	2.2	2.4	1.3	0.5	6.4
1945	2.0	2.7	1.4	0.6	6.7
			Percentage distribution		
1870	72.4	14.6	5.2	7.8	100 0
1880	67.9	17.4	7.3	7.4	100.0
1890	62.1	21.7	8.7	7.5	100.0
1900	55.1	27.8	10.4	6.7	100.0
1910	48.8	32.0	13.4	5.8	100.0
1920	44.0	35.0	15.2	5.8	100.0
1930	39.4	35.7	18.2	6.7	100.0
1940	33.9	37.9	19.7	8.5	100.0
1945	30.1	40.6	20.5	9.4	100.0

Source : Statistical Yearbook of Sweden 1951.

civil and public services and in the independent professions showed a relative fall from 7.8 % in 1870 to 5.8 % in 1920. As from 1920, however, both of these occupational groups have shown a very substantial increase. They might appropriately be jointly designated as « service industries »; and while they comprised only 13 % of the total population in 1870, the corresponding figure had risen to 21 % in 1920 and 29.9 % in 1945. In other words, these service industries represented, in 1945, approximately the same proportion of the total population as the agricultural group. Expanding industry brought with it a redistribution of labour among the various branches of industry and commerce. The rapidly mounting need of labour in industry was covered partly from the surplus of agricultural workers, partly through the natural increase in population.

These changes in the trend of national production, with an expansion of industry and public services and a decline of agriculture, also brought about changes in the localization of economic and industrial activity.

During the initial phase of industrialism in Sweden — dating approximately from 1860 to 1890 — the development of the iron and lumber industries, both of which were localized to the provinces, culminated. Several other industries too were localized to rural districts, such as the paper and glass industries, distilleries, brickworks, flour mills, etc. As regards the swiftly expanding textile industry at that time, the manufacture of yarn was localized to rural and the weaving mills to urban areas. Thus Swedish industry has been localized in great part to small rural townships; and in 1896, when the expansion started in earnest, only about one third of the total industrial population worked in urban areas. During this period the location of new enterprises in the lumber, metal and engineering industries was determined in great part by natural factors — raw material supplies, access to water power and natural transport routes. Right up to the close of the nineteenth century, foundries, iron works and sawmills were localized to places with waterfalls that could be harnessed. With the mounting importance of steam as a source of energy, and even more through electrotechnical advances, factories became less dependent on waterways. The expansion of the railway network, and the improvement of communications in general, also contributed to a radical change in the requisites for the localization of industry.

Hence the engineering industry, which was now commencing to expand, could be localized to more densely populated areas and towns, even if they had no access to water power. The lumber industry in the northern parts of the country moved from the inland districts, with their waterfalls, to steam-operated sawmills in the coastal areas. During this period the localization of the agricultural population also played a major role, directly and indirectly, in that of large parts of the expanding urban industries and in much of those activities that were dependent on local markets. Many towns and densely populated areas that had originally been centres of commerce or administrative centres in major agricultural zones, became focal points of urban industries. In the agricultural industries too, certain changes of localization occurred which influenced movements of the population. For instance, the expansion of sylviculture in the northern parts of the country led to increased agricultural operations in those areas. The increased employment in commerce contributed to the emergence of numerous small but densely populated areas, both in the agricultural regions and along the new lines of communication.

Between 1896 and 1930, the number of industrial workers doubled. The greatest expansion occurred in the metal and engineering industries, in which the number of workers at the end of that period was treble that at the beginning. The new concerns in the engineering industry were chiefly localized to the towns. Shifts

in the local distribution of industrial workers were relatively limited, however, up to 1930. A major part of industry was localized to the towns, particularly in those counties in which the four largest cities are situated.

Between 1930 and 1945, occupation in industry increased by 185 000 workers, or about 12 000 per annum, which in absolute figures is virtually double the annual increase during the period from 1896 to 1930. Just over one half of this increase was assignable to the metal and engineering industries, which in 1945 comprised almost one third of the country's industrial workers. The expansion of the metal industry was mainly localized to the towns in southern and central Sweden. The textile and clothing industries too showed a substantial expansion, referable notably to those regions to which they had previously been localized.

During this period comparatively great changes occurred in the relative distribution of industrial workers in different regions. The proportion of industrial workers resident in the counties of the four largest towns decreased from 34.8 to 32.7 % in 1945. In respect of Stockholm, which had 10.3 % of the country's industrial workers in 1930, the figure for 1945 was 9.9 %. The regional distribution of population has also been influenced substantially by the service industries, commerce, administration, and the independent professions. The number engaged in these service industries was roughly quadrupled between 1870 and 1945, the total population having increased by only about 50 % in the same period.

These service industries might, with respect to localization, be divided into two main groups : one comprising markedly decentralized activities of the retail-trade and local-administrative type; the other consisting of activities concentrated to major regional centres or to the capital. The latter group, the importance of which has substantially increased in recent years, is in principle competitive and like from the standpoint of localization, but in practice its localization has been concentrated in great measure to the major towns, especially Stockholm. This expansion has been one factor stimulating the rapid development of the major towns. In Stockholm, for instance, the proportion of the service industries in the total population mounted from 47 % in 1900 to 60 % in 1945. Of the total increase in the service industries during this period, roughly one fourth was referable to the capital, the corresponding increase in respect of manufacturing, etc., having been only about one tenth.

For Sweden, like the majority of industrialized countries the inter-war years may be described as a « second industrial revolution », though the changes this time were not so far-reaching as those in the nineteenth century.

The yield of industrial activity, however, increased very rapidly in the nineteen-twenties and thirties. New trends in regard to products and processes (rationalization, mechanization, etc.) characterized most branches of industry. Entirely new or improved qualities of products played a major role in the development of production, e.g. in the iron, the engineering, the building materials, the paper pulp, and the food industries, and perhaps above all in the chemical and ready-made clothing industries. A survey of such new or improved products from a recent study by E. Dahmén (1) is given in *Table 10*, showing their increased importance between 1919 and 1939.

During the same period, major changes also occurred outside industry proper, primarily in the fields of transportation and communication, through the rapid development of road traffic, electrification of rural areas, broadcasting, and air transportation. Dahmén's study also contains a survey of the formation and winding up of firms in

(1) [illegible] *Entrepreneurial Activity in Swedish Industry in the Period 1919-1939*, Stockholm, 1950.

TABLE 10.

Survey of the « transformation » of production in the inter-war period.

	Sales value of production in tenths of one per cent (‰) of the aggregate sales value of Swedish industrial production (1).	
	1919	1939
Sponge iron	0.0	0.3
Electro-steel	1.3	9.7
Various alloys	0.1	3.8
Various new rolled (especially cold rolled) and drawn products, etc.		8.6
Aluminum and aluminum products	0.3	2.6
Various manufactures not produced within the iron works (fittings included)	0.3	6.2
Various non-ferrous metal castings	2.1	3.4
Central-heating boilers and low pressure steam boilers		1.4
Central-heating radiators	0.2	2.5
Airplanes and automobiles	1.1	20.9
Motor cycles and bicycles	3.5	5.9
Various new transport equipment, etc.		1.9
Electrical heating apparatus, etc.	0.3	1.4
Radio receivers		3.9
Various electrical household appliances	0.2	5.0
Various new electrical apparatus, etc.		5.1
Pumps, fans, air conditioning equipment, etc.	0.9	3.9
Various business machines and office appliances		1.8
Various new instruments and tools (i. a. pneumatic)	—	2.7
Various new types of industrial machinery		8.5
Various new agricultural and dairy machinery		2.0
Various concrete goods and light-weight concrete	1.8	4.3
Porcelain equipment for electrical installations and sanitary goods	—	0.5
Various new types of bricks and pottery products		2.5
Glasswool and miscellaneous new glassware		0.4
Plywood	0.1	1.1
Wallboard		4.1
Prefabricated wooden houses		4.1
Prefabricated wood furnishings and other newly developed products of wood-working		3.9
Various wood products (i. a. impregnated)	0.1	0.6
Bleached sulphite pulp (i. a. viscose cellulose)	4.1	12.9
Bleached sulphate pulp (of an entirely new character)		3.3
Various sorts of paper and paperboard	0.7	7.1
Hard corrugated board and paper		1.2
Various new paper and paperboard products		2.4
Mineral water and sweet aerated drinks	2.0	3.6
Various preserved products, jam and juice, etc.	1.1	4.5
Various foods (i. a. milk powder, condensed milk)	0.0	0.6
Cattle feed	1.8	7.0
Various textiles (i. a. machine felt, binder twine)	0.3	1.6
Rayon products	—	13.1
Garments and other ready-made clothing products	13.6	29.6
Various fur, rubber and leather products	0.7	8.0
Cellulose enamels, synthetic enamels and varnishes, etc.		1.6
Miscellaneous new products of the drug industry		1.1
Synthetic nitrogen products	—	0.6
Mineral oils, bakelite, vegetable oils, medical preparations, etc.	1.2	7.9
Total	37.8	230.2
Total, percentage figures	3.8	23.0

(1) Mineral products, gold and silver ware, military equipment, flour mill, dairy and butchery products excluded.

Swedish industry during the inter-war years (*Table 11*). The first two columns show the rate of entry of new firms and the rate of exit of old firms. The next two columns illustrate the significance of the entry and exit of firms with regard to employment. The « formation percentage » (F) shows, in respect of individual industries, the percentage of the total number of workers in 1939 employed by firms founded during the inter-war years. The « discontinuation percentage » (D) shows corresponding figures in relation to 1919 for firms closed down during the inter-war period.

It emerges e. g. from *Table 11* that 50 % of the firms in the iron, steel, and metal manufacturing group in 1940 had started sometime between 1919 and 1939. Of the number of workers in 1939, 19 % were employed by firms established since 1919. Of the firms existing in 1919, 23 % had been closed down before 1940, and these undertakings employed 10 % of the number of workers in 1919. The table shows too that the rate of entry of new firms during that period was very high in respect of the furniture, prefabricated wooden houses and wallboard industries, the paper and paperboard processing industries, and the hosiery and ready-made clothing industries.

Thus, a large number of new firms were established in the inter-war years and, from the standpoint of employment, in many trades played just as great a role as did the firms existing at the start of the period. In certain trades large numbers of firms closed down, as in earlier years.

This formation of new companies, like the winding up of old ones, has naturally entailed certain changes in the regional distribution of population, production, and demand for transport services. It was most extensive in rural districts and in smaller urban agglomerations both in absolute figures and in relation to the number of firms at the end of 1919. Concurrently with the advent of these new firms, there was an expansion of older undertakings localized to the larger urban agglomerations, and at the same time a pronounced increase in commerce and other service industries there. The number of firms closed down was greatest, both in absolute figures and relatively, in the medium-sized, large and largest agglomerations. Moreover, a certain shift in the concentration of firms can be observed from the major agglomerations to the smaller ones. In 1939, no fewer than 48 major concerns employing over 500 workers were situated in fairly small agglomerations, and only 22 in the three largest cities. Yet no major number of new agglomerations came into being during the inter-war period by industrial developments. The existence of unusually large numbers of big concerns outside the major towns, which has long been typical of Sweden, is due tot the fact that the localization of two of the principal industries, iron manufacturing and forestry, has been determined by the access to raw materials and power. Company formation in the inter-war years, however, was but little governed by similar considerations; the reason why it was localized in great part to the smaller agglomerations is probably that the improved communications enhanced the possibilities of localization further away from the markets, while the electrification of rural districts facilitated industrial operations outside the larger towns. According to Dahmén there is moreover, a conspicuous concentration of these inter-war firms to places served by railways; the markedly improved potential business for road transport manifestly did not entail decisive tendency to establish them at considerable distances from railway communications. In contrast to what had been earlier the case, it was not primarily the natural factors, access to raw materials or power, that determined the localization of new firms in Sweden during inter-war years. Nor was that localization determined to the same extent as before by the distance to the principal markets for their products. On the contrary, the human element, it was pointed out in Dahmén's report, may be said to have determined in

TABLE 11.

Survey of the formation and discontinuation of firms in the inter-war period.

GROUPS AND BRANCHES OF INDUSTRIES	Number of enterprises started 1919-1939 and in operation in 1940 in per cent of total number Dec., 31, 1939	Number of enterprises discontinued 1919-1939 and started before 1919 in per cent of total number Jan., 1, 1919	F	D
Iron and steel works	0	53	0	15
Iron, steel, and metal manufacturing and engineering industries	50	23	19	10
Machinery and allied products industry (electrical engineering industries excluded)	42	33	14	16
Electrical engineering	74	44	23	16
Cement industry	30	22	12	26
Brick works	9	15	6	10
Potteries and earthenware industry	26	52	5	36
Furniture and wood-working industries (wallboard excluded)	61	27	49	33
Wooden houses	100	100	100	100
Wallboard	100	0	100	0
Pulp industries	13	23	19	8
Paper and paperboard mills	18	18	16	7
Industries based on, or processing paper and paperboard	58	30	32	26
Cocoa and candy, and fruit processing industry	58	41	17	15
Oleomargarine industry	58	32	47	3
Canning industry	59	26	46	22
Cotton industry	36	27	3	7
Woolen and worsted industry	15	29	2	14
Hosiery and knitted goods industry	72	28	38	14
Garment and ready-made clothing industry	77	40	50	26
Tanneries	12	72	3	32
Gloves, hide, and fur products	68	27	44	30
Paint and varnish industry	55	35	17	25
Oil, soft soap, perfumes and cosmetics industry	55	44	25	37

many cases the choice of location; for no less than about 80 % of all new firms were established at the place where the founder or one of the founders resided.

Another important change in the structure of industry applied to the size of the firms. The distribution of industrial workers among establishments of various sizes, *Table 12*, shows that the bulk have been employed at those of medium size, if we take this to mean those employing between ten and a maximum of 500 workers. A study of the trend between 1913 and 1945 shows that both the small firms employing a maximum of ten and the large ones with over 500 employees mounted in importance.

The increased importance of major establishments reflects that tendency to large-scale operations which has characterized industrial developments. That of the minor establishments is due to several factors, chiefly perhaps the advent and rapid development of road transport during the past few decades. Road traffic has improved the transport facilities and led to a relative fall in the freight rates for minor consignments, which probably has strengthened considerably the competitive power of the small industries. The rapid development of motor traffic has also necessitated a large number of small repair shops scattered throughout the country. Another important contributory factor in the advent of small enterprises lies in the introduction of the electric motor, which has satisfied in a rational way the power needs of small-scale concerns. Moreover, the higher standard of living and the growing urbanization have increased the need of service industries and manufactures of various high-quality products, which work cannot proceed on a large scale but must be done by small concerns with relatively extensive regional distribution.

The development of economic life in other industrialized countries of the world, with expansion of manufacturing and service industries and decline of agriculture, with growing urbanization, suburbanization and relocation of industries and changes in the demand for transportation services, etc. has been about the same as in Sweden. Productivity has increased considerably in most countries, both in agricultural and industrial production, due to increasing

TABLE 12.

Percentage distribution of workers in Swedish industry among establishments classified as to size by number of workers employed.

Year	SIZE OF ESTABLISHMENT				
	-10	10-50	50-200	200-500	500-
1913	5.8	19.9	30.6	24.6	19.1
1920	7.0	20.9	27.9	24.5	19.7
1930	8.5	20.1	25.4	24.5	21.5
1940	9.4	20.0	23.8	18.8	28.0
1945	9.4	21.8	25.2	17.3	26.4

Source : Statistical Yearbook of Sweden 1951.

mechanization of production processes, use of power and improved management methods. The increased production has made possible a constantly rising standard of living for the population of the different countries. To a great extent this increased standard has been manifested in an augmented consumption of personal services of various kinds, which has resulted in a rapid growth of service industries during the last few decades.

All over the world, industry is trying to eliminate useless transportation and save freight costs through better location of plants, simplification of production processes and elimination of waste of materials. Improvements in technology admitting the use of materials formerly wasted and, particularly, production of better materials and better designs have caused a declining tendency in the relative transportation needs of certain industries. As examples of such developments to better and longer-lived materials may be named the increased use of alloy steels, minimizing rusting and making the steel more durable, the development of light metals as aluminum and of various synthetic resins, refinements in production processes and increased use of statistical quality control tests assuring higher quality of commodities produced.

An extended use of scraps of different kinds, scrap iron, scrap paper, etc., as raw materials in production have brought a considerable elimination of transportation of primary raw materials, e. g. iron ore and coal, causing a net loss of traffic in tons and ton-km for transport agencies, especially railways. Scrap-iron has thus come to mean more and more for the production of iron and steel. The production-technical explanation of this fact is the augmented use of Martin and electro-steel processes, which are especially fit for melting scrap-iron. To illustrate the great importance of scrap it can be mentioned that only some 40 % of the Swedish iron production is now based on iron ore, whilst 60 % comes from re-melting scrap.

The increasing substitution of electric energy for coal is another example of this tendency to reduce relative transportation needs measured in tons and ton-km of industry. In U. S. A. the rapid growth of pipelines for transport of natural gas, substituting gas for other fuels, chiefly coal and oil, represents shrinkage of the tonnage volume of freight transportation required.

Interregional shifts of industry have occurred in most countries. Thus in Great Britain a movement of certain branches of industry from the northern to the southern parts of the country has been proceeding since the nineteen-twenties. Historically, industry developed mainly in the North because the principal sources of raw materials were there. The increasing importance of service industries and consumer goods industries, combined with the improvements of transportation facilities and the development of electric power all over the country, has greatly reduced the relative importance of raw materials in the choice of location. As a result, market considerations, proximity to the big London market, have come to play a more important role than before, and industry has been attracted to the southern part of the country.

Such examples of industrial and population movements can be found in several other countries. In U. S. A. significant economic changes have taken place during the last thirty years. Certain regions have developed much more rapidly than the country as a whole, while others have lagged behind the national rate of growth. The rate of growth has been most rapid for the western, midwestern and southern regions of the country. This trend has brought a certain equalization of the interregional distribution of population and industry and an equalization of the degree of industrialization of the different regions. « Although the three north-eastern regions of the nation are the most highly developed, the other regions of the country are gaining ground and the tendency is toward a narrowing of the economic differentials that exist between the regions of the coun-

try. » « That the western states are narrowing the economic differentials that exist between them and the eastern states is clearly evident. » (1)

Industrial and population drifts have also occurred in U. S. S. R., Germany, Belgium (decline in the Mons-Charleroi area and increase in Antwerp and elsewhere) and most other industrialized countries.

Another relocation movement in industry that has been going on since the nineteen-twenties is the outward movement of industry from the centres to the outskirts of the bigger cities or to newer neighbouring cities (suburbanization). Such shifts of industry mostly intraregional, have been proceeding all over the world promoted by the development of automobile transport and urban transport facilities, which gave many light industries greater latitude in choosing location relative to raw materials, markets and labour supply, and made it possible for workers to reside in the outskirts of the cities. There is a general tendency nowadays to use the centres of the cities for administrative, commercial and entertainment purposes, and to place industrial plants and residential districts in the suburbs.

These regional shifts and variations in industry and population cause changes in the traffic structure, increasing the demand for transport services at the newer locations and decreasing the demand at some of the old locations. As the facilities of transportation usually expand more rapidly at the new locations than they are contracted at the older ones, these regional shifts and variations in industry and population may give rise to regional surpluses of transport facilities until readjustments can be made. Owing to the heavy investments and the highly specialized nature of these facilities, especially as regards the railways, such adjustments to changed conditions may take a long time to initiate and to fulfil.

(To be continued.)

(1) Director H. B. Mc Coy : *Office of Domestic Commerce, Traffic World.* June 2, 1951.

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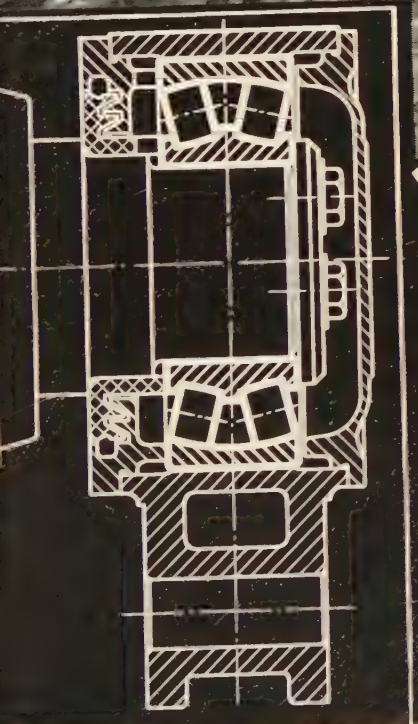

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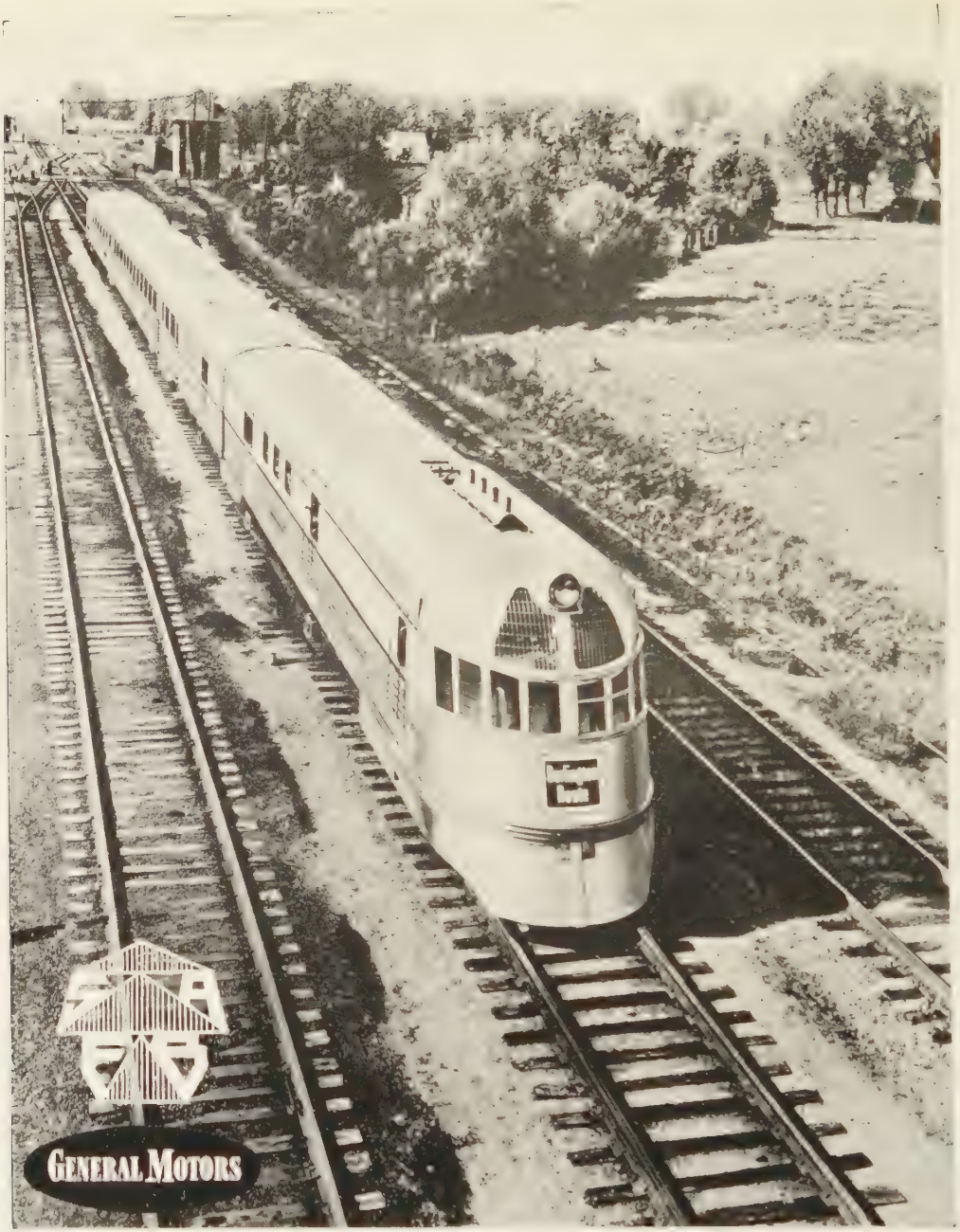

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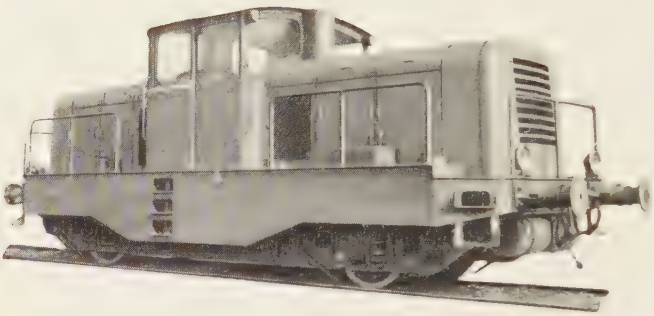

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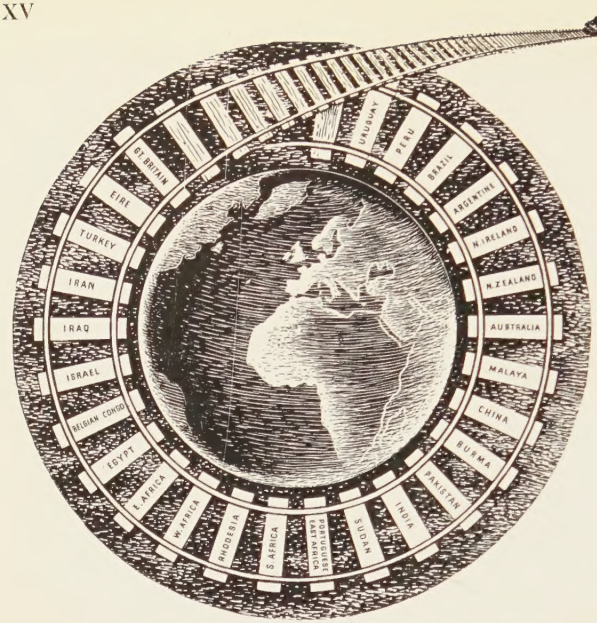

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